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Kim et al.

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(54) **MULTI-TIER CLUSTERING APPARATUS IN WIRELESS COMMUNICATION SYSTEM AND METHOD THEREOF**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 277 days.

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(22) Filed: **Apr. 2, 2013**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
H04W 28/16 (2009.01)
H04W 28/18 (2009.01)
H04W 72/08 (2009.01)

(52) **U.S. Cl.**
CPC ***H04W 28/16*** (2013.01); ***H04W 72/085*** (2013.01)

(58) **Field of Classification Search**
CPC H04W 72/048; H04W 48/20; H04W 28/0226; H04W 28/16; H04W 72/085; H04W 72/087
USPC 455/410, 411; 726/4, 27
See application file for complete search history.

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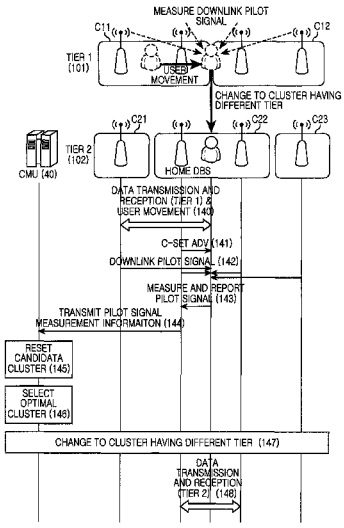
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

An apparatus and a method for configuring and managing/controlling a cluster, which is a set of Base Stations (BSs) for transmitting signals cooperatively, are provided. The method includes broadcasting cluster set information indicating information about a plurality of clusters including a serving BS to a User Equipment (UE), receiving a report of information about Received Signal Strength Indicators (RSSIs) of control signals transmitted from BSs included in the plurality of clusters from the UE, and assigning any one of the plurality of clusters to a cluster for servicing the UE based on the information about the RSSIs of the control signals.

24 Claims, 18 Drawing Sheets



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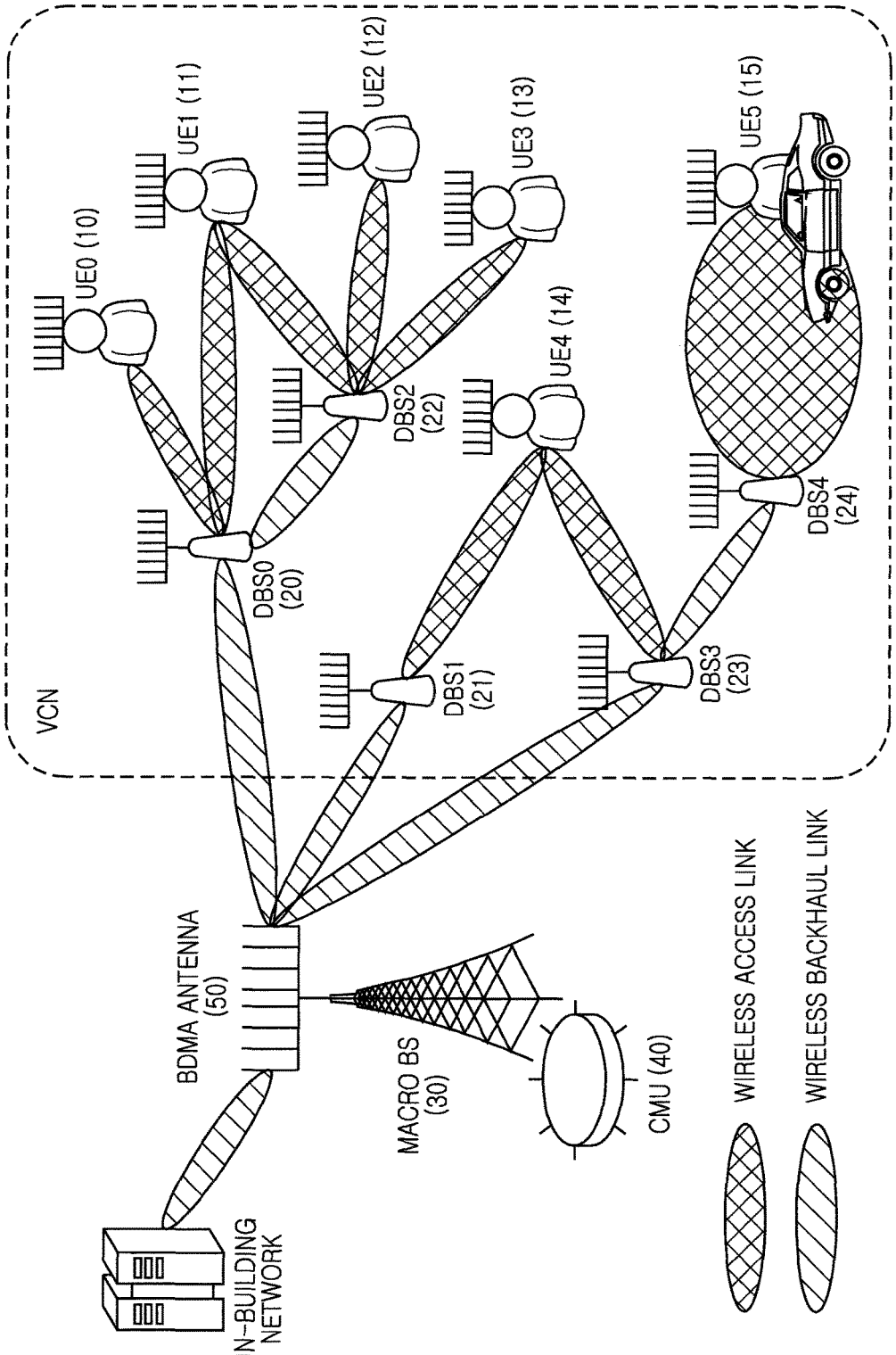
VCN
UE0 (10)
UE1 (11)
UE2 (12)
UE3 (13)
UE4 (14)
UE5 (15)
DBS0 (20)
DBS1 (21)
DBS2 (22)
DBS3 (23)
DBS4 (24)
BDMA ANTENNA (50)
MACRO BS (30)
CMU (40)
IN-BUILDING NETWORK
WIRELESS ACCESS LINK
WIRELESS BACKHAUL LINK

FIG.1

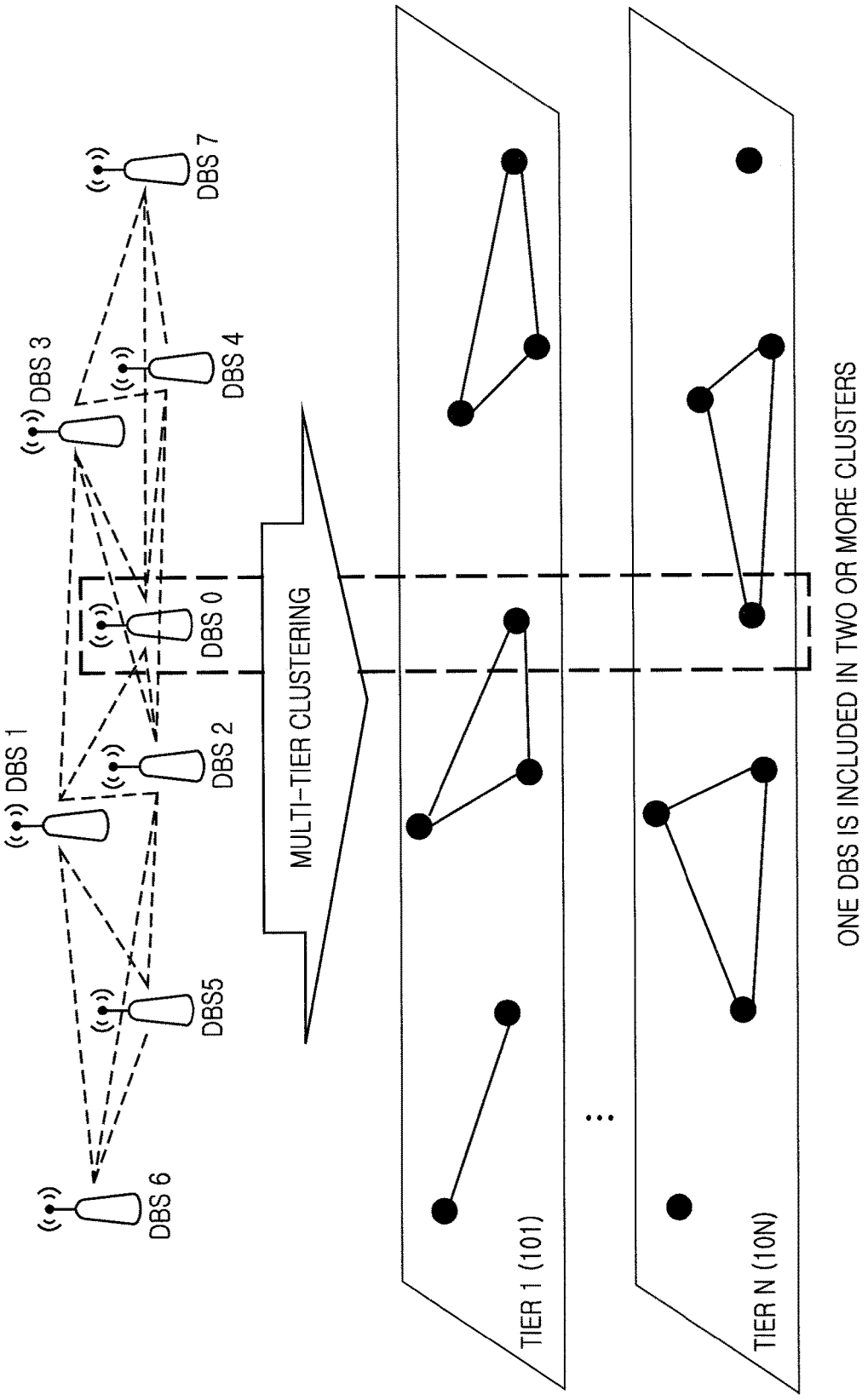
DBS 7
DBS 3
DBS 4
DBS 0
DBS 1
DBS 2
DBS5
DBS 6
MULTI-TIER CLUSTERING
TIER 1 (101)
TIER N (10N)
ONE DBS IS INCLUDED IN TWO OR MORE CLUSTERS

FIG.2

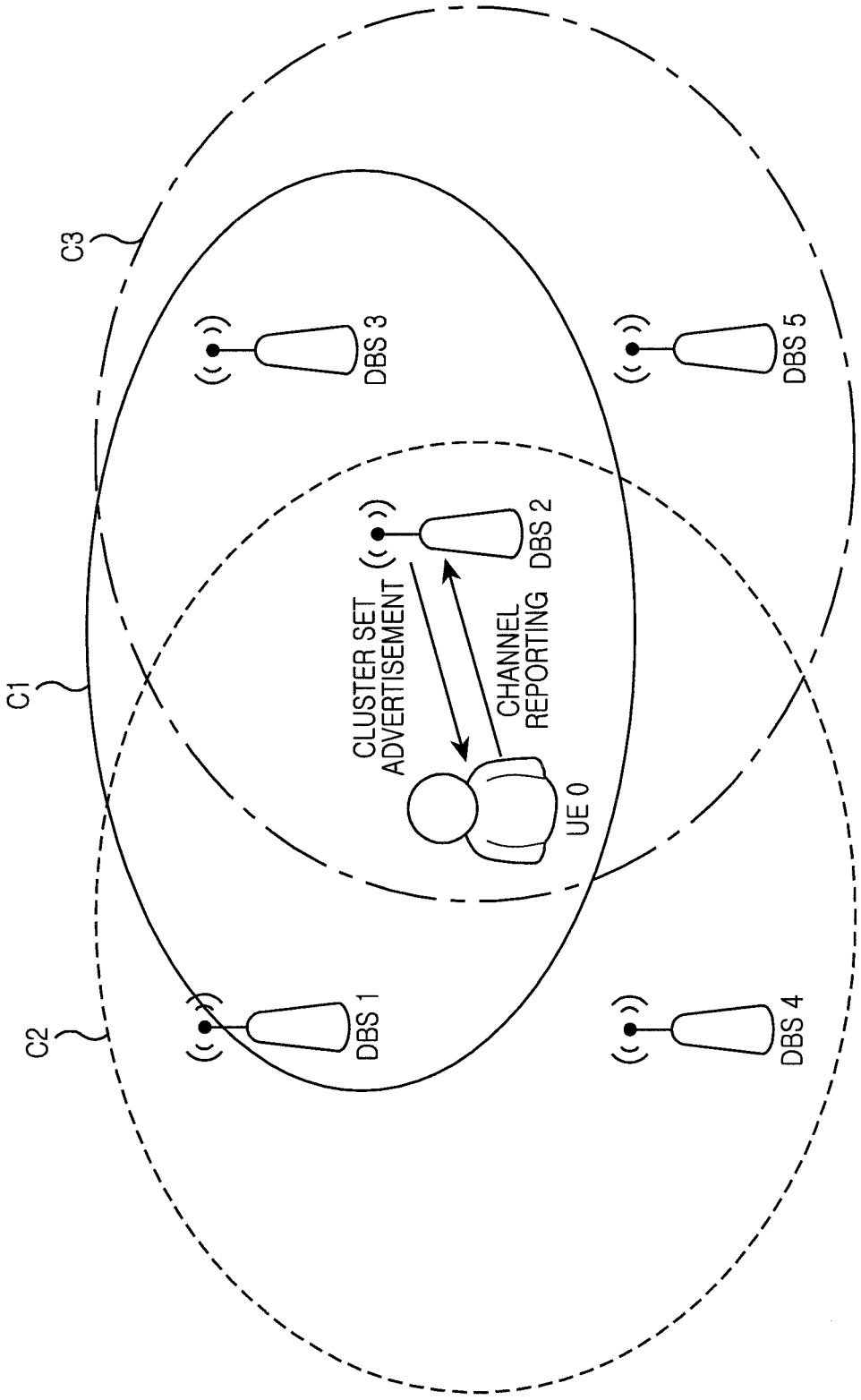
C3
C1
C2
DBS 3
DBS 5
DBS 2
DBS 1
DBS 4
CLUSTER SET ADVERTISEMENT
CHANNEL REPORTING
UE 0

FIG.3

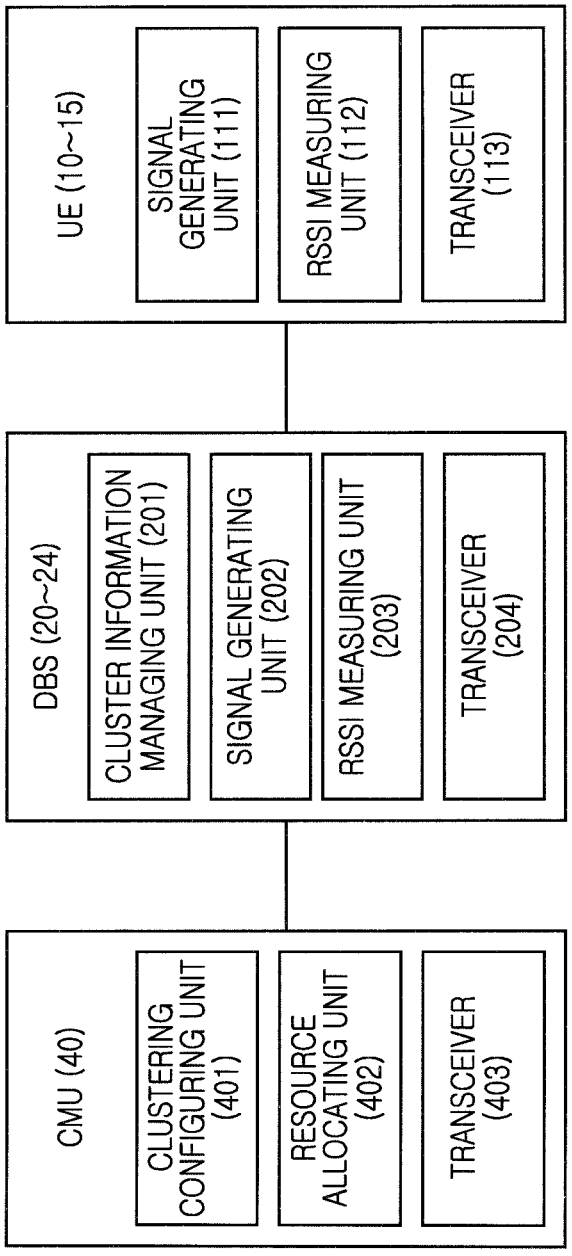
UE (10~15)
SIGNAL GENERATING UNIT (111)
RSSI MEASURING UNIT (112)
TRANSCEIVER (113)
DBS (20~24)
CLUSTER INFORMATION MANAGING UNIT (201)
SIGNAL GENERATING UNIT (202)
RSSI MEASURING UNIT (203)
TRANSCEIVER (204)
CMU (40)
CLUSTERING CONFIGURING UNIT (401)
RESOURCE ALLOCATING UNIT (402)
TRANSCEIVER (403)

FIG. 4

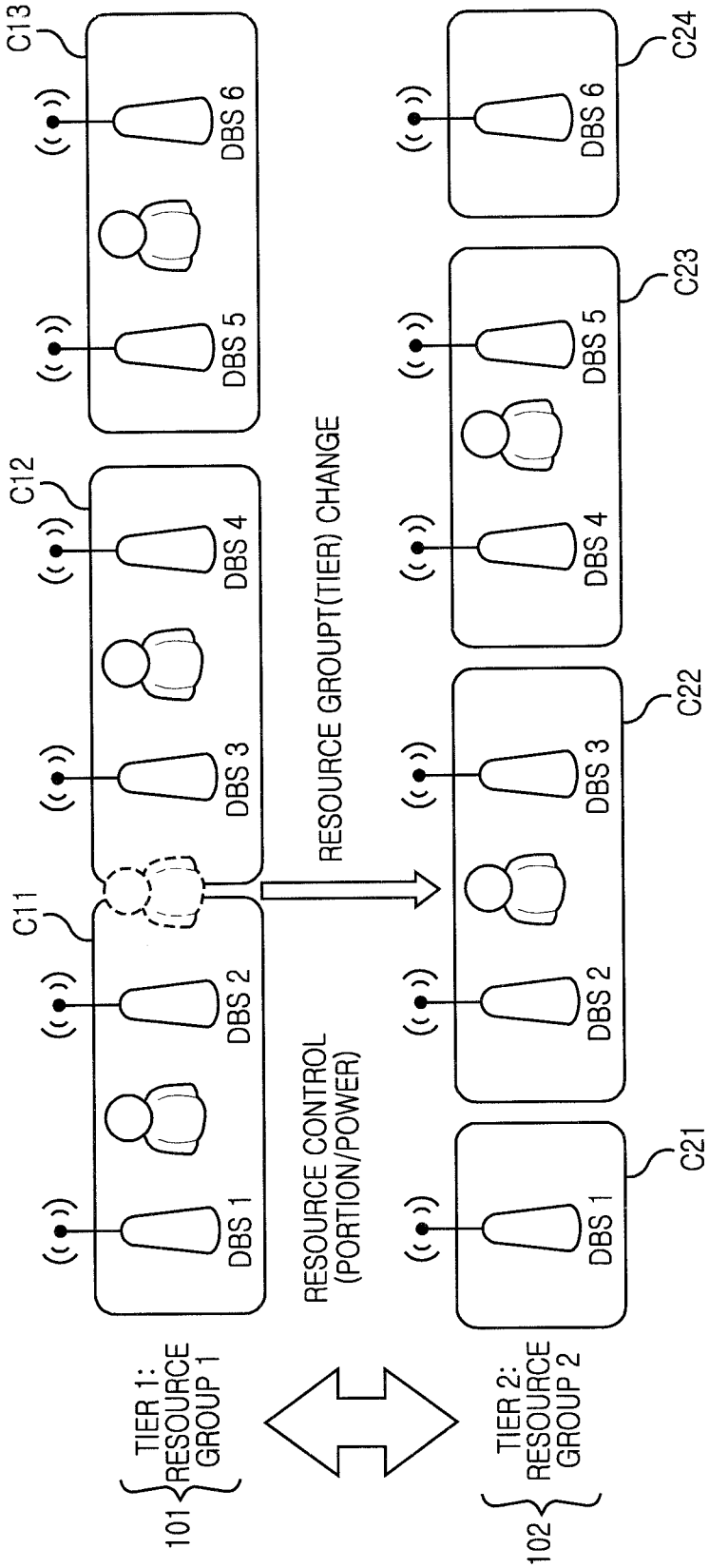
C13
DBS 6
DBS 5
C12
DBS 4
DBS 3
C11
DBS 2
DBS 1
RESOURCE GROUPT(TIER) CHANGE
RESOURCE CONTROL
(PORTION/POWER)
C24
DBS 6
C23
DBS 5
DBS 4
C22
DBS 3
DBS 2
C21
DBS 1
TIER 1:
RESOURCE
GROUP 1
101
TIER 2:
RESOURCE
GROUP 2
102

FIG.5

FIG.6A

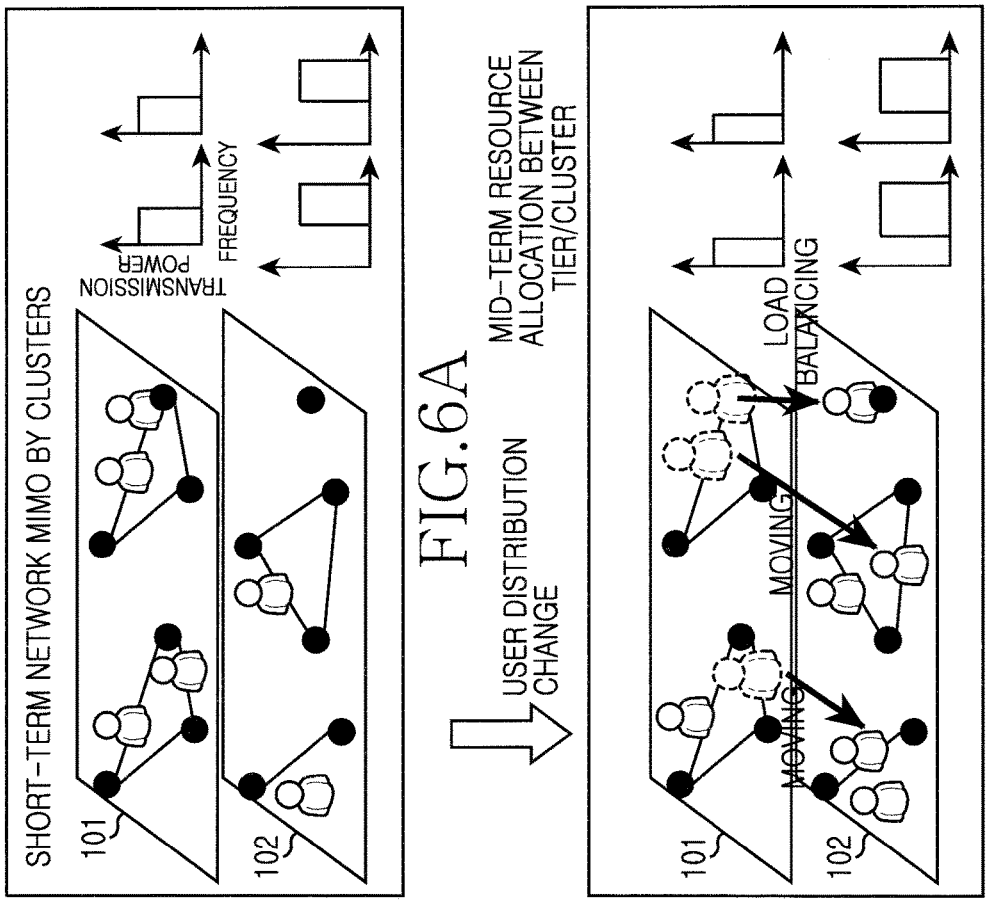

FIG.6B

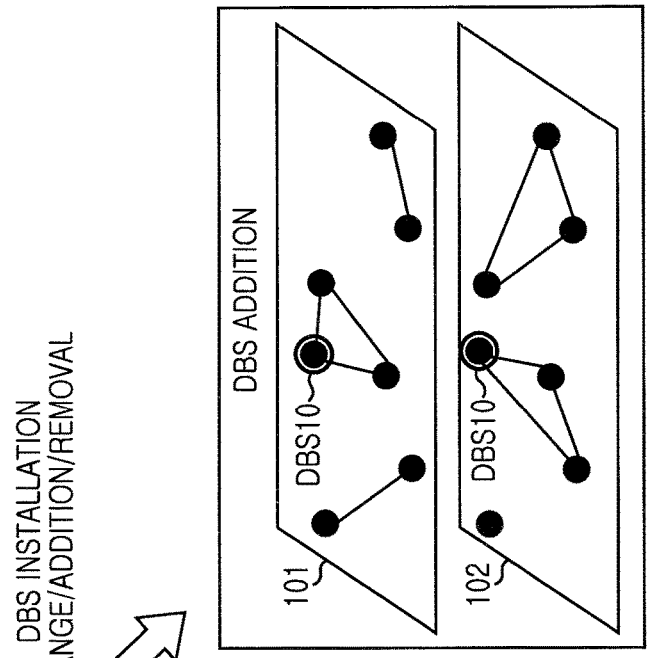

FIG.6C

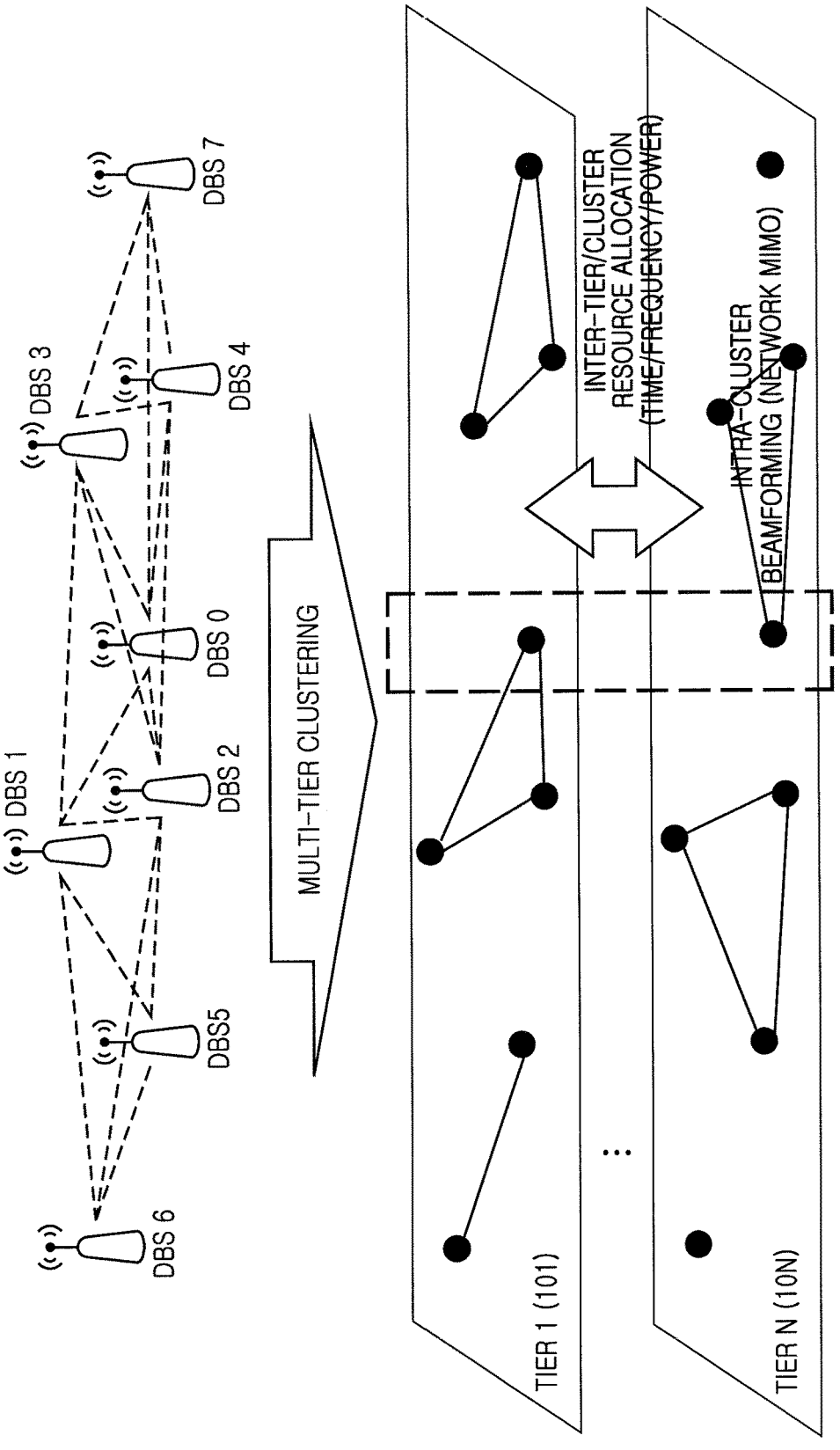
DBS 7
DBS 3
DBS 4
DBS 0
DBS 1
DBS 2
DBS5
DBS 6
MULTI-TIER CLUSTERING
INTER-TIER/CLUSTER RESOURCE ALLOCATION (TIME/FREQUENCY/POWER)
INTRA-CLUSTER BEAMFORMING (NETWORK MIMO)
TIER 1 (101)
TIER N (10N)

FIG.7

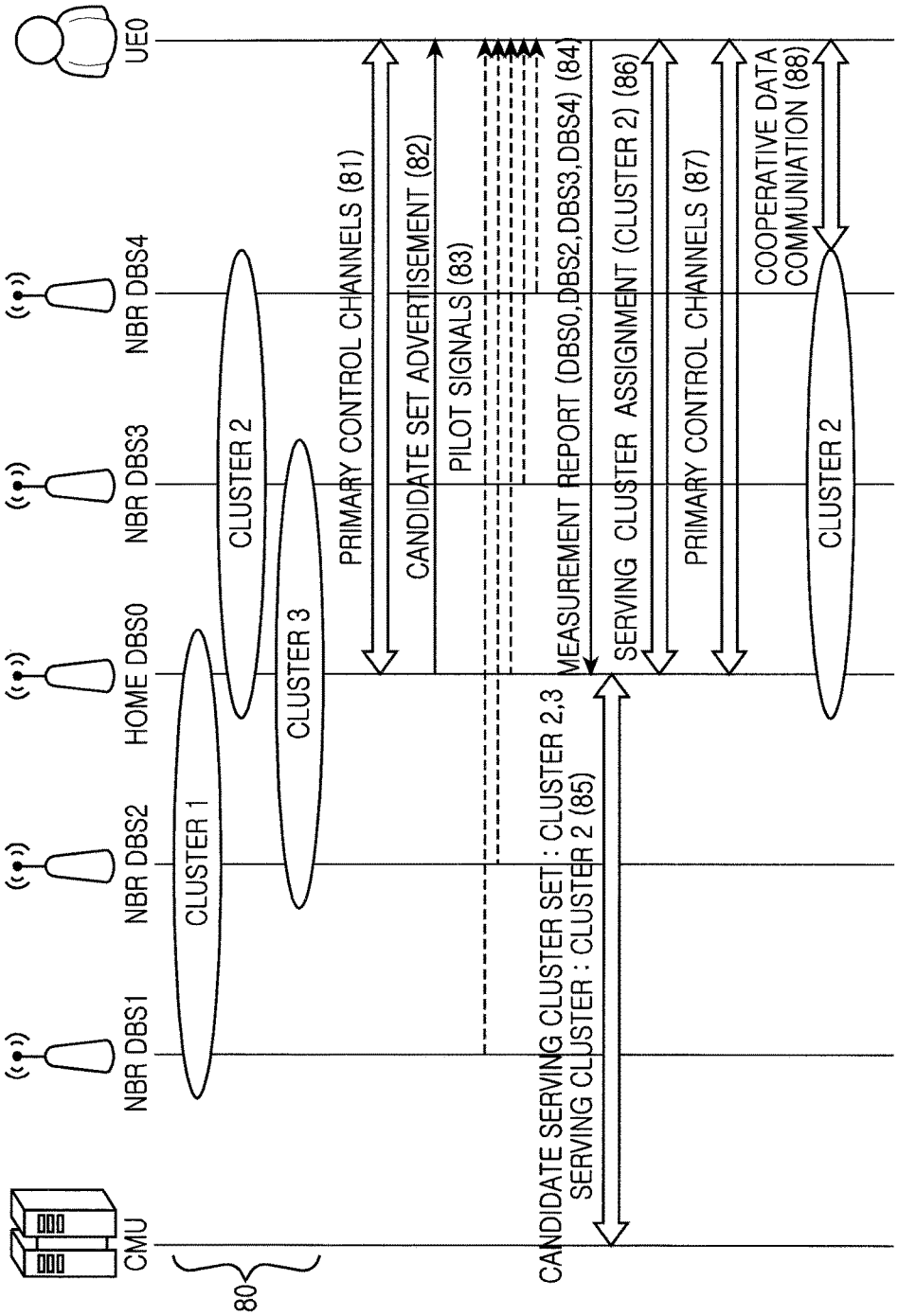
UE0
NBR DBS4
NBR DBS3
HOME DBS0
NBR DBS2
NBR DBS1
CMU
80
CLUSTER 1
CLUSTER 2
CLUSTER 3
PRIMARY CONTROL CHANNELS (81)
CANDIDATE SET ADVERTISEMENT (82)
PILOT SIGNALS (83)
MEASUREMENT REPORT (DBS0,DBS2,DBS3,DBS4) (84)
SERVING CLUSTER ASSIGNMENT (CLUSTER 2) (86)
PRIMARY CONTROL CHANNELS (87)
COOPERATIVE DATA COMMUNIATION (88)
CLUSTER 2
CANDIDATE SERVING CLUSTER SET : CLUSTER 2,3
SERVING CLUSTER : CLUSTER 2 (85)

FIG.8

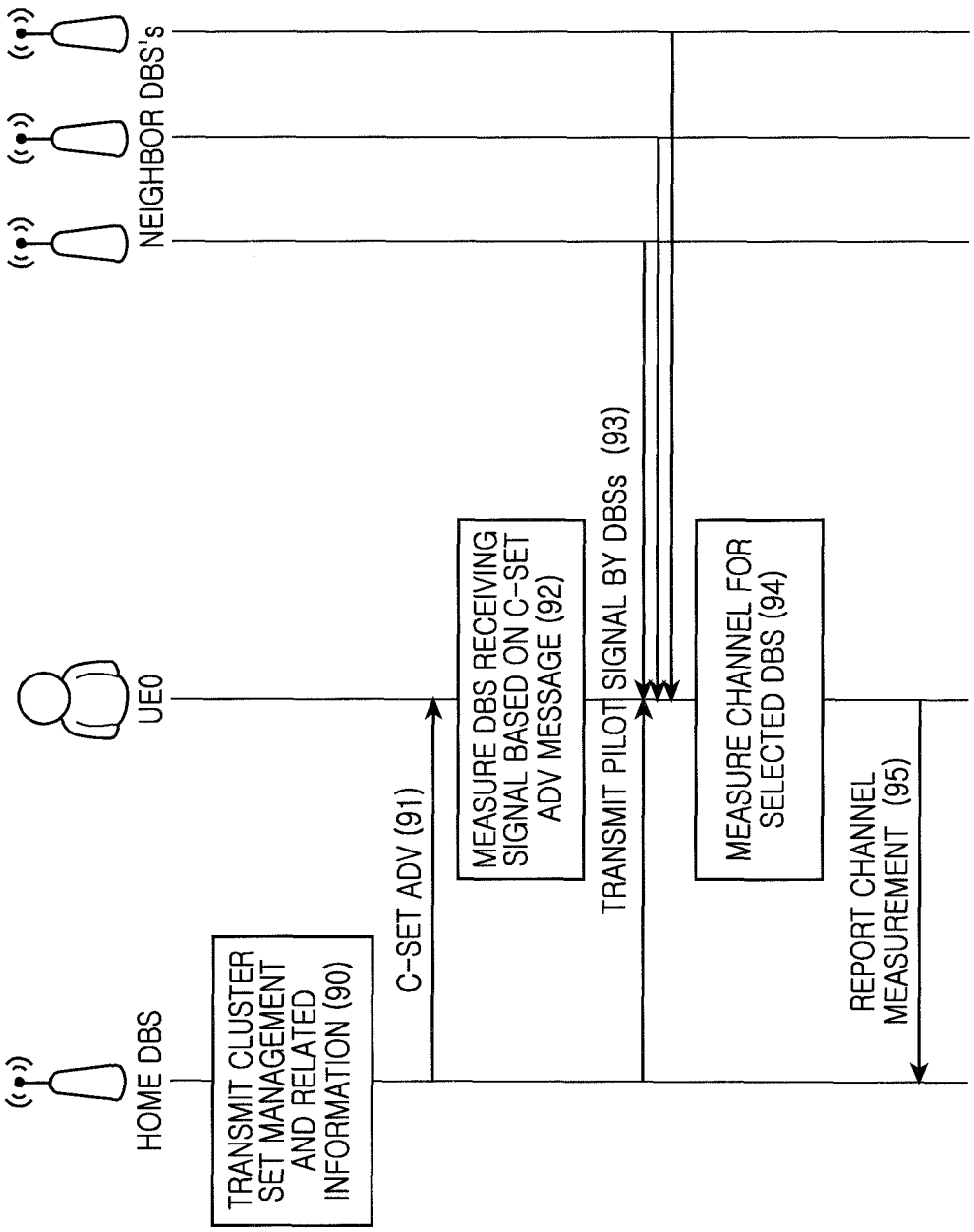
NEIGHBOR DBS's
UE0
HOME DBS
TRANSMIT CLUSTER SET MANAGEMENT AND RELATED INFORMATION (90)
C-SET ADV (91)
MEASURE DBS RECEIVING SIGNAL BASED ON C-SET ADV MESSAGE (92)
TRANSMIT PILOT SIGNAL BY DBSs (93)
MEASURE CHANNEL FOR SELECTED DBS (94)
REPORT CHANNEL MEASUREMENT (95)

FIG.9

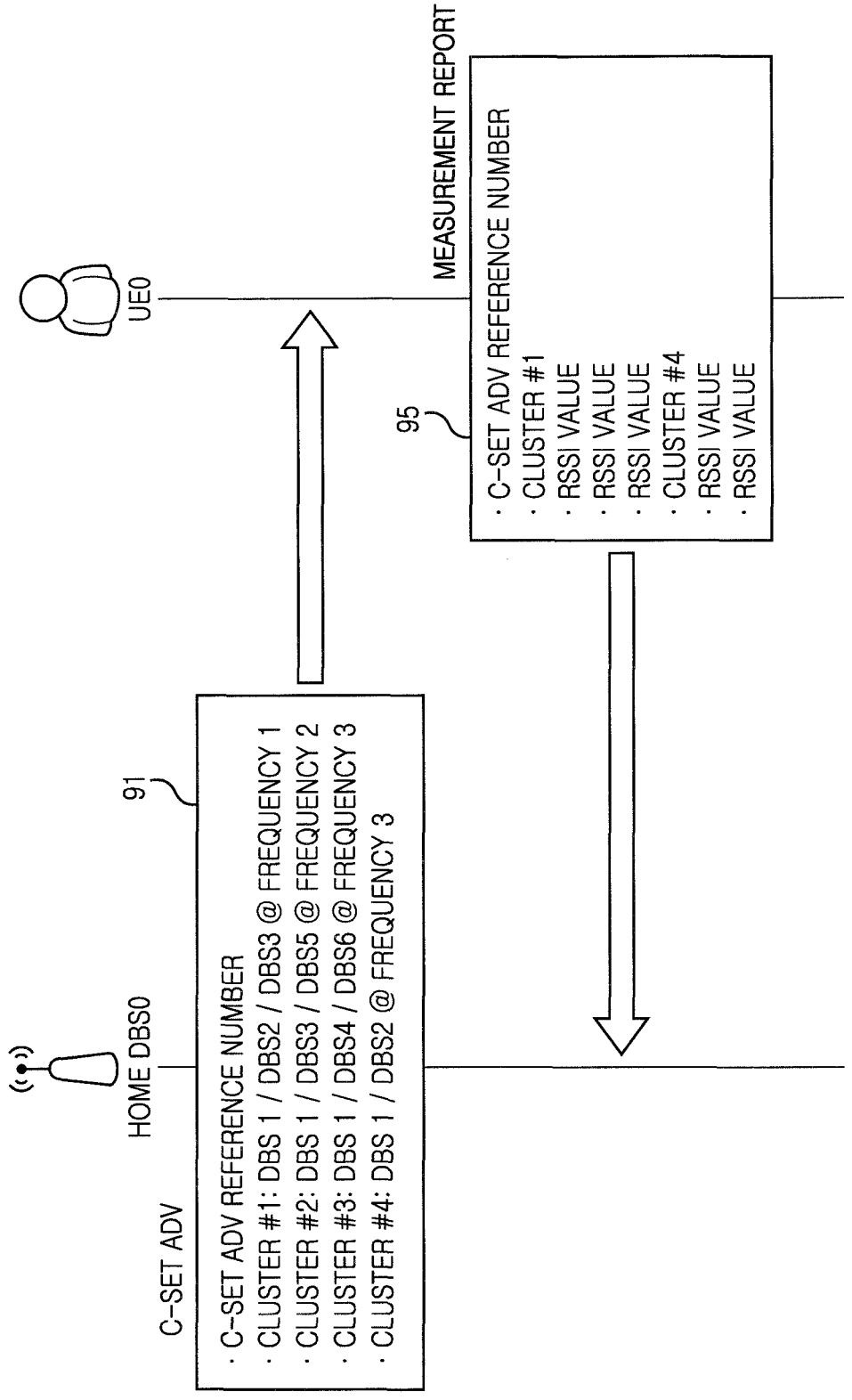
HOME DBS0
UE0
C-SET ADV
91
· C-SET ADV REFERENCE NUMBER
· CLUSTER #1: DBS 1 / DBS2 / DBS3 @ FREQUENCY 1
· CLUSTER #2: DBS 1 / DBS3 / DBS5 @ FREQUENCY 2
· CLUSTER #3: DBS 1 / DBS4 / DBS6 @ FREQUENCY 3
· CLUSTER #4: DBS 1 / DBS2 @ FREQUENCY 3
MEASUREMENT REPORT
95
· C-SET ADV REFERENCE NUMBER
· CLUSTER #1
· RSSI VALUE
· RSSI VALUE
· RSSI VALUE
· CLUSTER #4
· RSSI VALUE
· RSSI VALUE

FIG.10

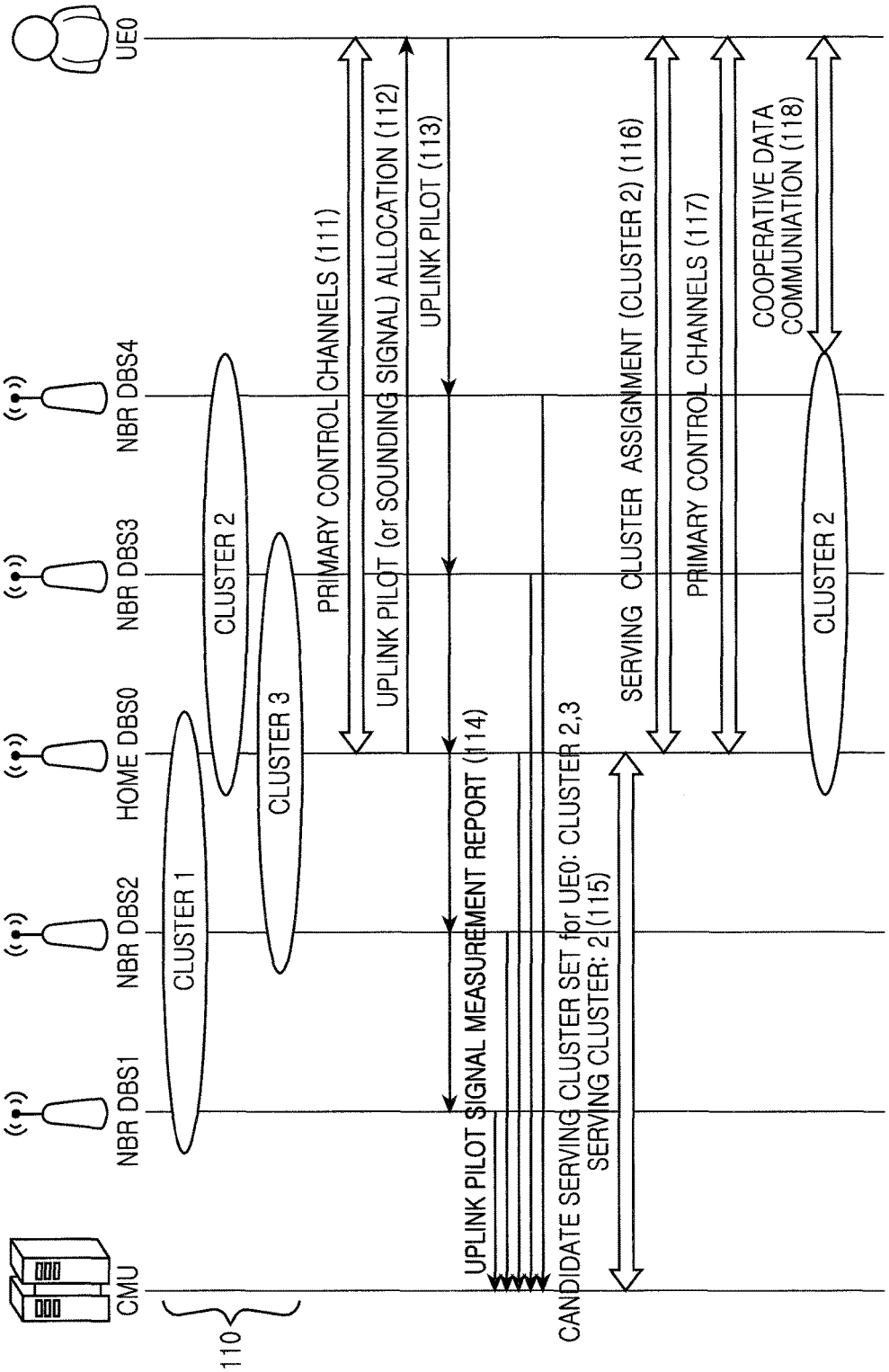
UE0
NBR DBS4
NBR DBS3
HOME DBS0
NBR DBS2
NBR DBS1
CMU
110
CLUSTER 1
CLUSTER 2
CLUSTER 3
PRIMARY CONTROL CHANNELS (111)
UPLINK PILOT (or SOUNDING SIGNAL) ALLOCATION (112)
UPLINK PILOT (113)
UPLINK PILOT SIGNAL MEASUREMENT REPORT (114)
CANDIDATE SERVING CLUSTER SET for UE0: CLUSTER 2,3
SERVING CLUSTER: 2 (115)
SERVING CLUSTER ASSIGNMENT (CLUSTER 2) (116)
PRIMARY CONTROL CHANNELS (117)
COOPERATIVE DATA COMMUNIATION (118)
CLUSTER 2

FIG. 11

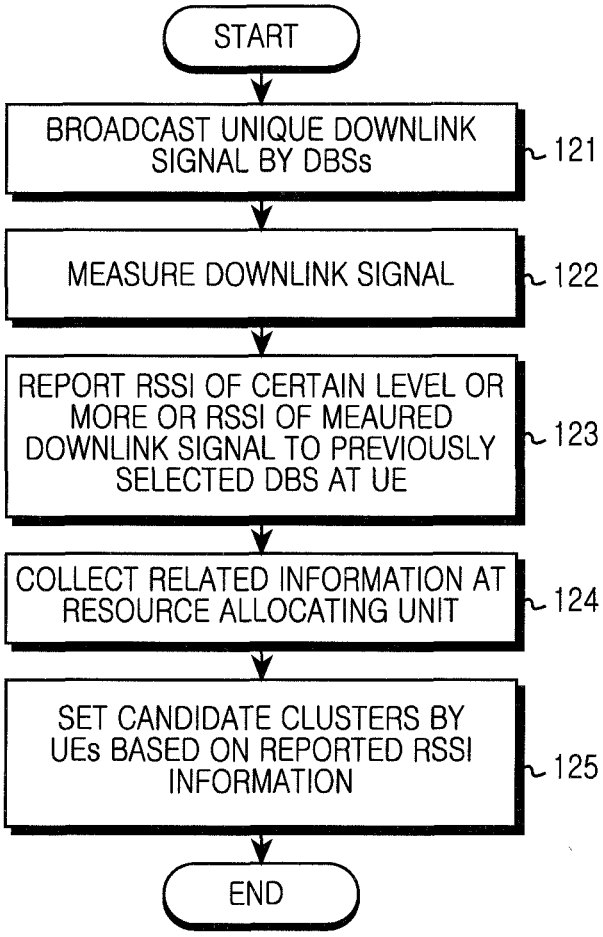
START
BROADCAST UNIQUE DOWNLINK SIGNAL BY DBSs
121
MEASURE DOWNLINK SIGNAL
122
REPORT RSSI OF CERTAIN LEVEL OR MORE OR RSSI OF MEAURED DOWNLINK SIGNAL TO PREVIOUSLY SELECTED DBS AT UE
123
COLLECT RELATED INFORMATION AT RESOURCE ALLOCATING UNIT
124
SET CANDIDATE CLUSTERS BY UEs BASED ON REPORTED RSSI INFORMATION
125
END

FIG.12

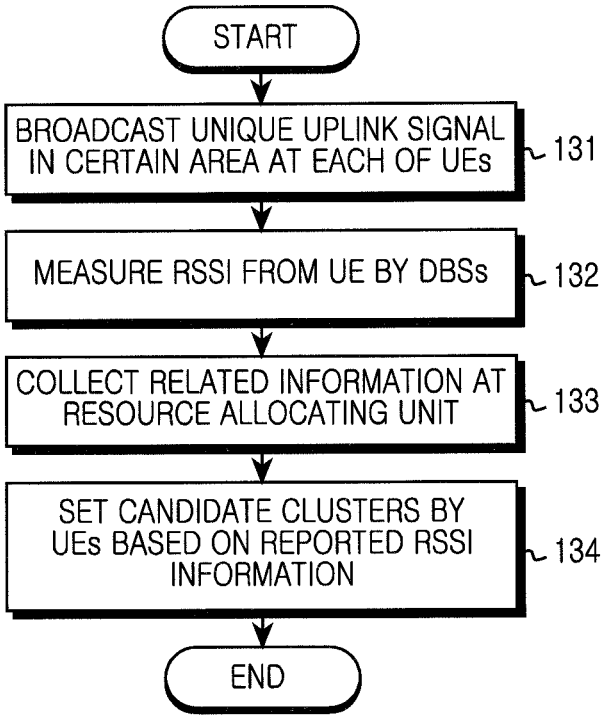
START
BROADCAST UNIQUE UPLINK SIGNAL IN CERTAIN AREA AT EACH OF UEs
131
MEASURE RSSI FROM UE BY DBSs
132
COLLECT RELATED INFORMATION AT RESOURCE ALLOCATING UNIT
133
SET CANDIDATE CLUSTERS BY UEs BASED ON REPORTED RSSI INFORMATION
134
END

FIG.13

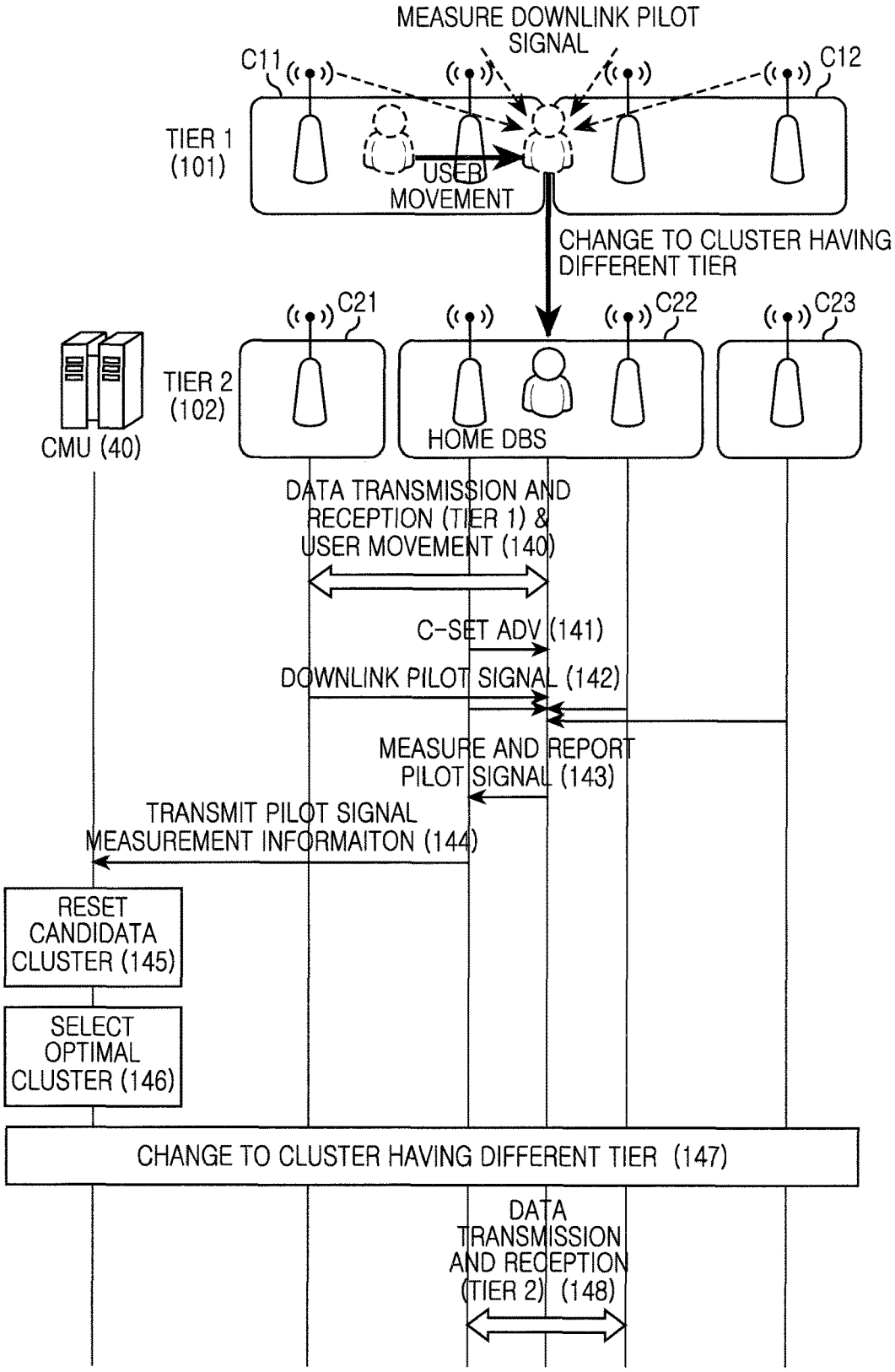
MEASURE DOWNLINK PILOT SIGNAL
C11
C12
TIER 1 (101)
USER MOVEMENT
CHANGE TO CLUSTER HAVING DIFFERENT TIER
C21
C22
C23
TIER 2 (102)
CMU (40)
HOME DBS
DATA TRANSMISSION AND RECEPTION (TIER 1) & USER MOVEMENT (140)
C-SET ADV (141)
DOWNLINK PILOT SIGNAL (142)
MEASURE AND REPORT PILOT SIGNAL (143)
TRANSMIT PILOT SIGNAL MEASUREMENT INFORMAITON (144)
RESET CANDIDATA CLUSTER (145)
SELECT OPTIMAL CLUSTER (146)
CHANGE TO CLUSTER HAVING DIFFERENT TIER (147)
DATA TRANSMISSION AND RECEPTION (TIER 2) (148)

FIG.14

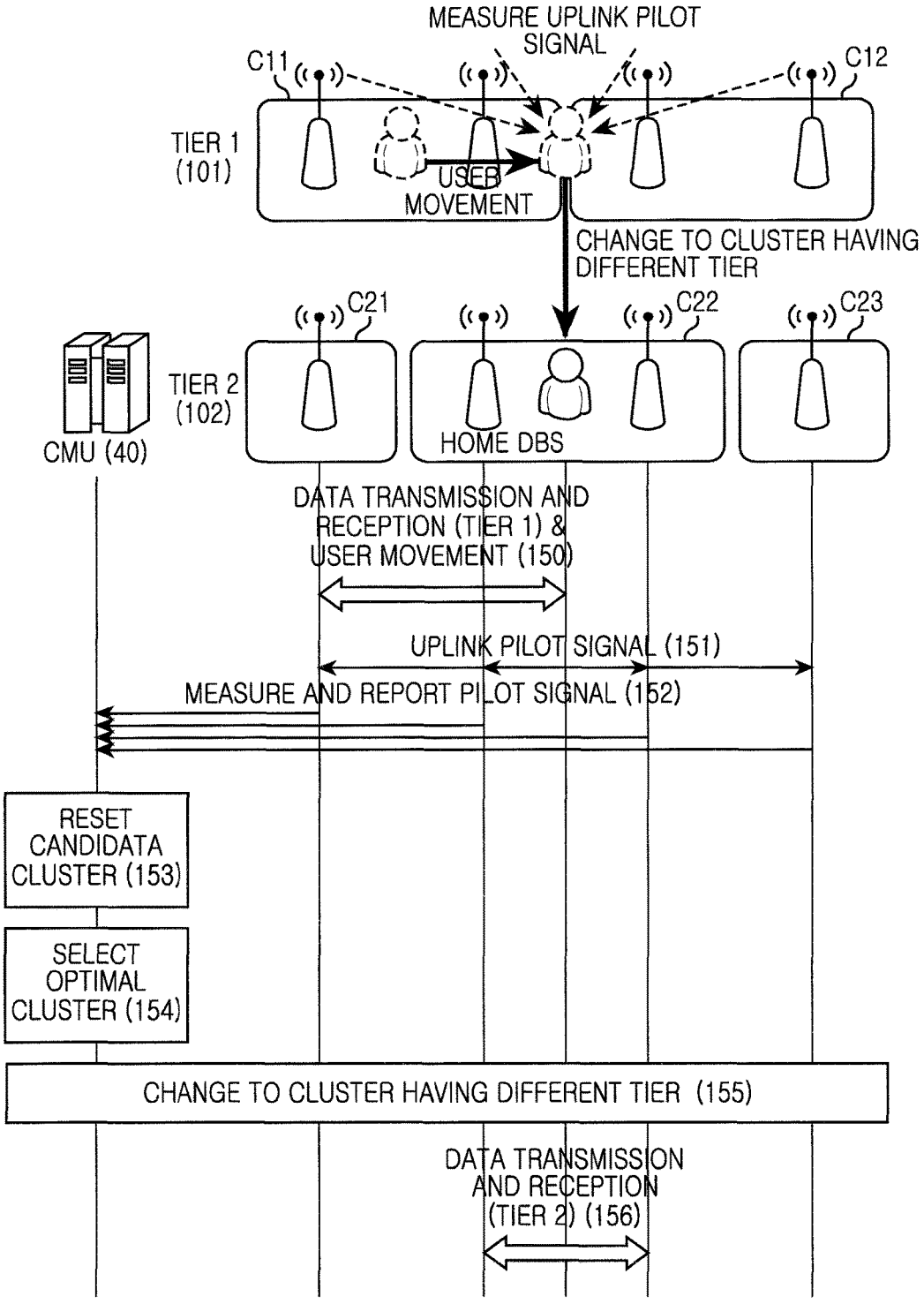
MEASURE UPLINK PILOT SIGNAL
C11
C12
TIER 1 (101)
USER MOVEMENT
CHANGE TO CLUSTER HAVING DIFFERENT TIER
C21
C22
C23
TIER 2 (102)
CMU (40)
HOME DBS
DATA TRANSMISSION AND RECEPTION (TIER 1) & USER MOVEMENT (150)
UPLINK PILOT SIGNAL (151)
MEASURE AND REPORT PILOT SIGNAL (152)
RESET CANDIDATA CLUSTER (153)
SELECT OPTIMAL CLUSTER (154)
CHANGE TO CLUSTER HAVING DIFFERENT TIER (155)
DATA TRANSMISSION AND RECEPTION (TIER 2) (156)

FIG.15

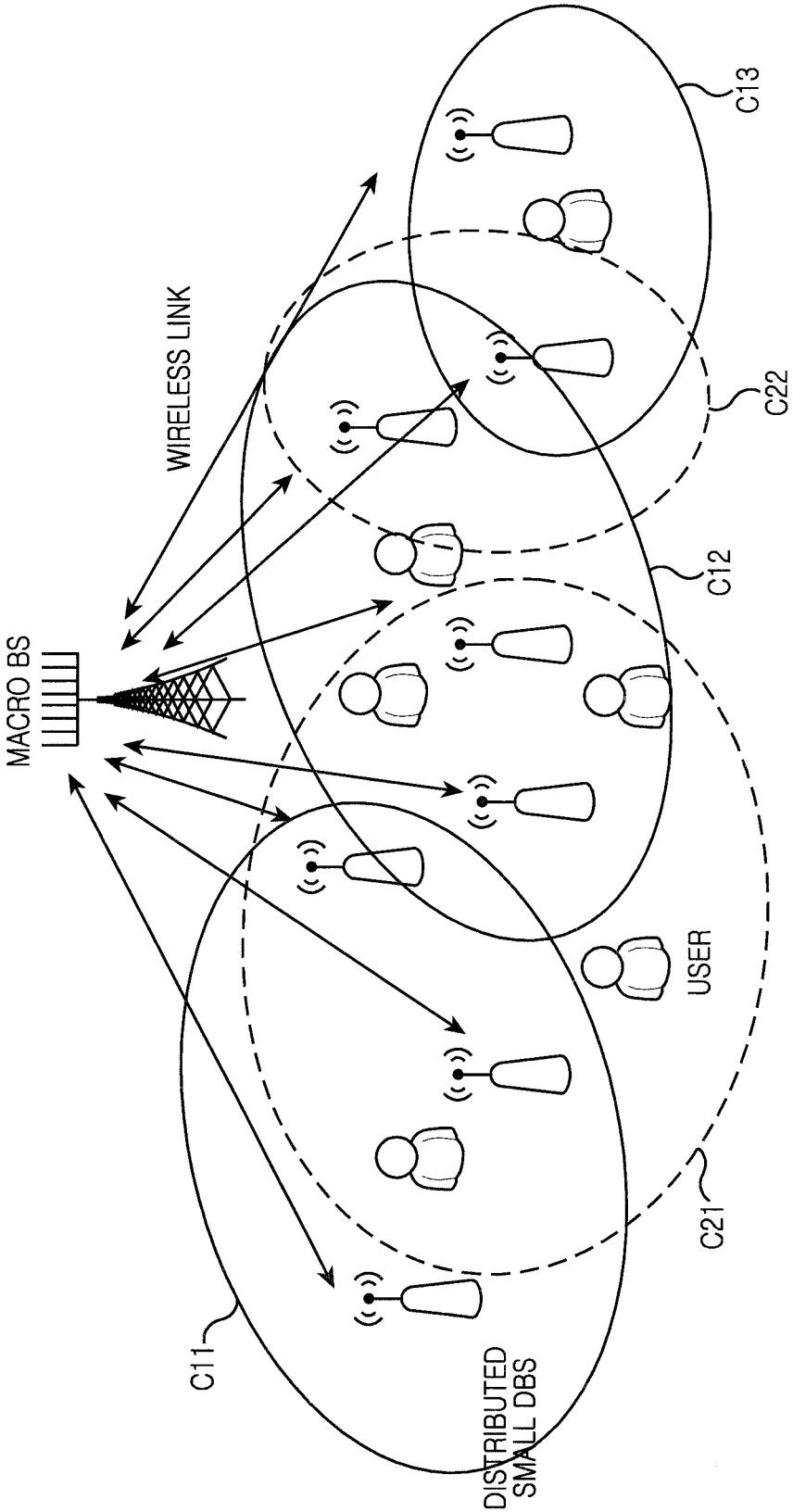
MACRO BS
WIRELESS LINK
C11
C12
C13
C21
C22
DISTRIBUTED SMALL DBS
USER
CLUSTER ON TIER 1
CLUSTER ON TIER 2

FIG. 16

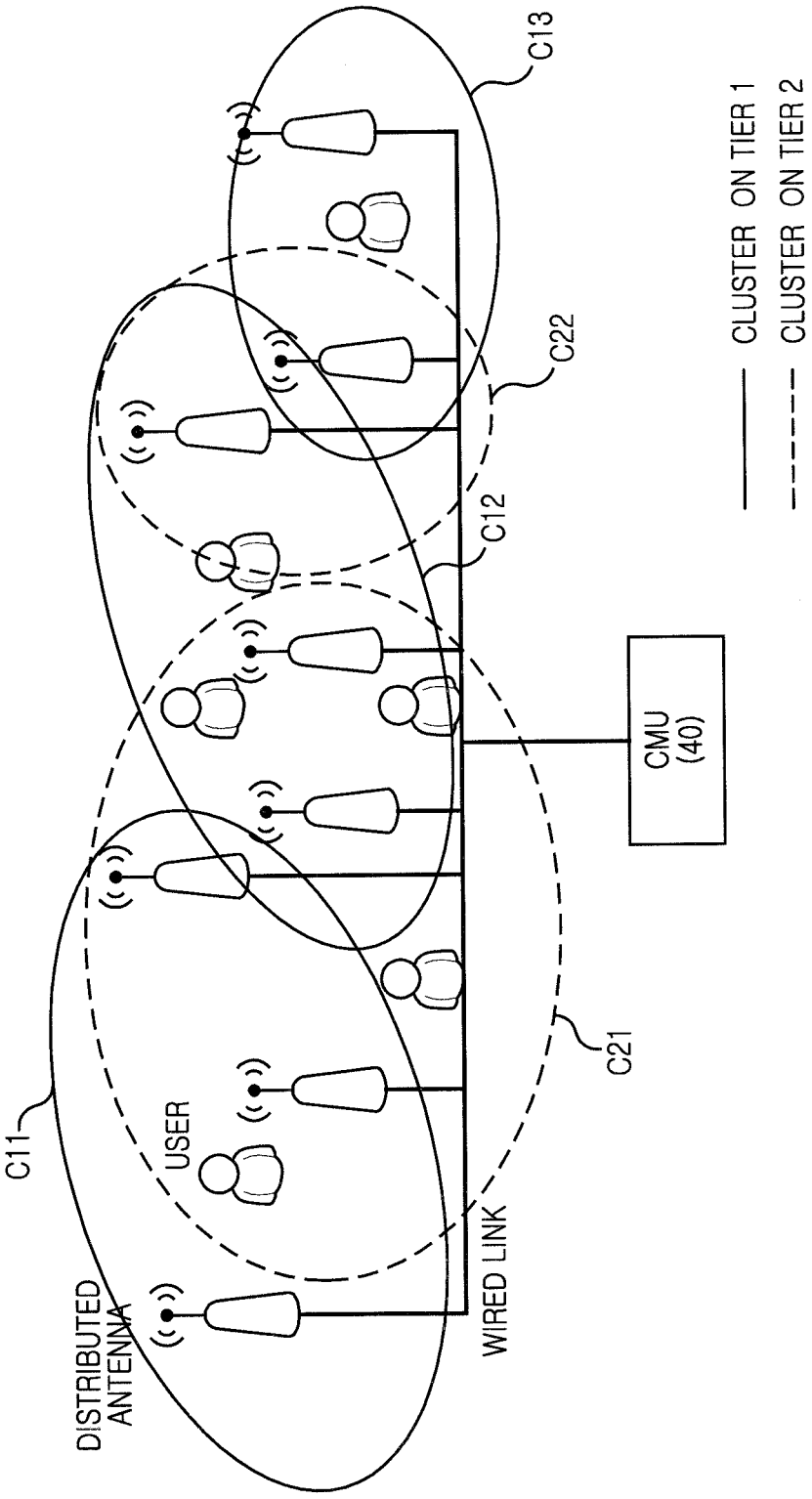
C13
C22
C12
C21
C11
CMU (40)
USER
DISTRIBUTED ANTENNA
WIRED LINK
CLUSTER ON TIER 1
CLUSTER ON TIER 2

FIG. 17

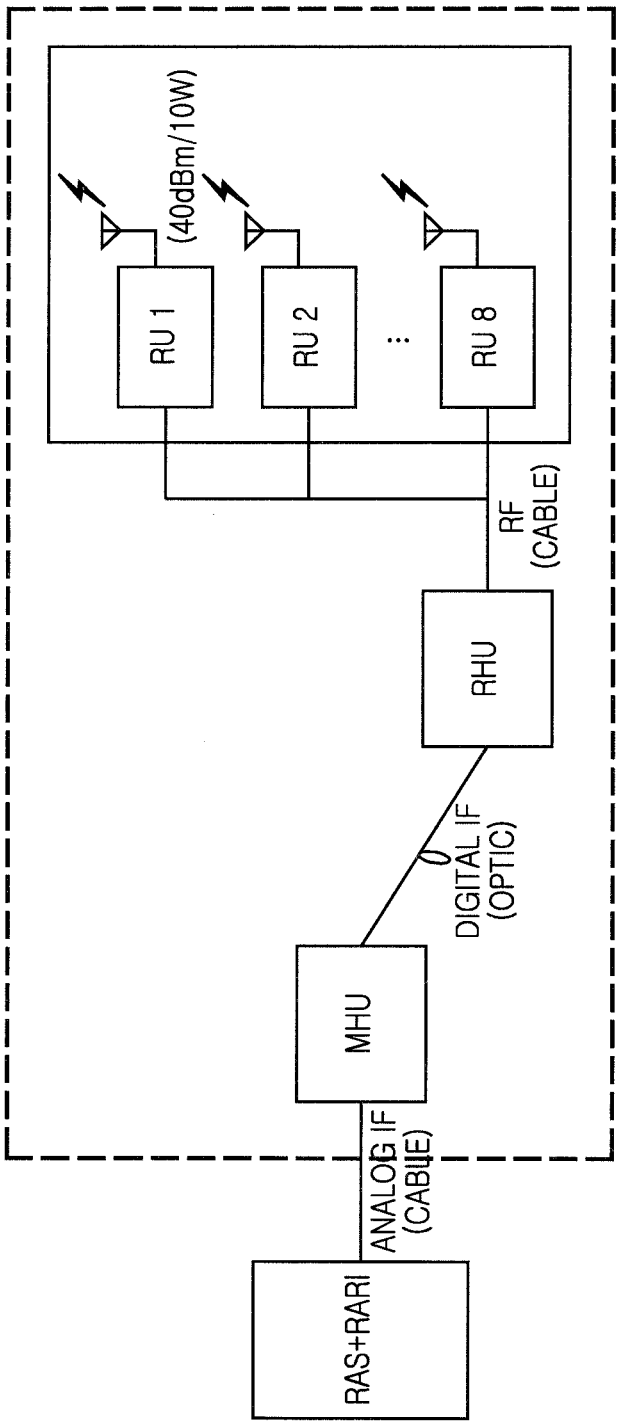
(40dBm/10W)
RU 1
RU 2
RU 8
RF (CABLE)
RHU
DIGITAL IF (OPTIC)
MHU
ANALOG IF (CABLE)
RAS+RARI

FIG.18

MULTI-TIER CLUSTERING APPARATUS IN WIRELESS COMMUNICATION SYSTEM AND METHOD THEREOF

PRIORITY

This application claims the benefit under 35 U.S.C. § 119(a) of a Korean patent application filed on Apr. 2, 2012 in the Korean Intellectual Property Office and assigned Serial No. 10-2012-0033988, the entire disclosure of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a mobile communication system. More particularly, the present invention relates to an apparatus and a method for configuring and managing/controlling a cluster, which is a set of Base Stations (BSs) for transmitting signals cooperatively.

2. Description of the Related Art

A cellular system, such as a mobile communication system, is a system proposed to overcome a limitation of a service area and a limitation of subscriber accommodation capacity. In this cellular system, several methods of increasing capacity of the system, such as a method of increasing the number of channels per unit size, and the like, have been actively studied.

Recently, in a communication network, such as a Virtual Cellular Network (VCN), several methods of increasing capacity of a system have been also considered. The VCN provides environments in which BSs reuse their space with one another and share data with one another. For example, small BSs capable of being easily installed/changed/deleted are placed in a VCN based on wireless backhaul. Because of sharing data among the BSs, if interference between clusters which are a set of the limited number of data sharing small BSs may be addressed, it is possible to increase capacity of a system. However, because the number of cooperative BSs considering a backhaul/complexity/channel estimation overhead is limited in VCN environments, an interference problem between clusters has been generated.

A disjoint clustering method and an overlapped clustering method have been proposed as methods of addressing interference between clusters. In accordance with the disjoint clustering method, clustering between BS clusters is performed to apply network Multi-Input Multi-Output (MIMO). Herein, each of the clusters is equipped with disjoint BS subsets. However, although the disjoint clustering method is performed, because there still is the interference problem between clusters, the fact that a solution for an interference problem between clusters of low complexity is requested is disclosed by L. Wang, C. J. Yeh who published "3-cell network MIMO architectures with sectorization and fractional frequency reuse" on June 2011 in the Institute of Electrical and Electronics Engineers (IEEE) Journal in Selected Areas of Communications (JSAC).

In accordance with the overlapped clustering method, it is permitted that each BS may belong to two or more clusters and a generation frequency of an interference problem between users who are located on a boundary between clusters is minimized. In one example, a multi-cell network MIMO scheduling method was proposed by S. Kaviani and W. A. Krzymien who published "Multicell scheduling in network MIMO" in Globecom 2010. However, in this method, complexity for a beamforming configuration is increased in comparison with performance improvement. In addition, the method is not linked to resource allocation, such as frequency reuse. In another example, a "intertwined clustering" method for forming different cluster patterns while being classified according to time/frequency resources was proposed, according to the invention, which is filed on May 24, 2010 to have a patent application Ser. No. 12/786,285, is published on Dec. 2, 2010 to have a patent publication number 2010/0304773, and is entitled "A method for selective antenna activation and per antenna or per antenna group power assignments in cooperative signaling wireless MIMO systems", by inventor Sean A. Ramprashad. However, this method has a limitation of a concept level or a limitation that only an operation in fixed BS distribution environments based on hexagonal cells is considered.

Therefore, a need exists for an apparatus and a method for configuring and managing/controlling a cluster which is a set of BSs for transmitting signals cooperatively.

The above information is presented as background information only to assist with an understanding of the present disclosure. No determination has been made, and no assertion is made, as to whether any of the above might be applicable as prior art with regard to the present invention.

SUMMARY OF THE INVENTION

Aspects of the present invention are to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the present invention is to provide an apparatus and a method for managing a corresponding cluster set by Base Stations (BSs) under multi-tier clustering environments.

Another aspect of the present invention is to provide an apparatus and a method for assigning a serving cluster by User Equipment (UE) under multi-tier clustering environments.

Another aspect of the present invention is to provide a processing method between BSs and a UE, for determining a cluster which services the UE under multi-tier clustering environments, and an apparatus therefor.

Another aspect of the present invention is to provide a processing method between BSs and a UE, for determining a cluster which services the UE under multi-tier clustering environments and changing the UE according to movement of a user, and an apparatus therefor.

In accordance with one aspect of the present invention, a processing method in a serving BS for determining a cluster which services a UE in a wireless communication system which includes the serving BS, a plurality of Distributed BSs (DBSs) including peripheral BSs for cooperating with the serving BS and for configuring clusters, and the UE, is provided. The processing method includes broadcasting cluster set information indicating information about a plurality of clusters including the serving BS to the UE, receiving a report of information about Received Signal Strength Indicators (RSSIs) of control signals transmitted from BSs included in the plurality of clusters from the UE, and assigning any one of the plurality of clusters to a cluster for servicing the UE based on the information about the RSSIs of the control signals.

In accordance with another aspect of the present invention, a processing method in a UE for determining a cluster which services the UE in a wireless communication system which includes a serving BS, a plurality of DBSs including peripheral BSs for cooperating with the serving BS and for configuring clusters, and the UE, is provided. The processing method includes receiving cluster set information indi-

cating information about a plurality of clusters, which is broadcasted from the serving BS, measuring RSSIs of control signals transmitted from BSs included in the plurality of clusters, reporting information about the measured RSSIs to the serving BS, and allowing the serving BS to assign any one cluster selected among the plurality of clusters to a serving cluster for a data service based on the information about the RSSIs of the control signals.

In accordance with another aspect of the present invention, a serving BS apparatus for determining a cluster which services a UE in a wireless communication system which includes a serving BS, a plurality of DBSs including peripheral BSs for cooperating with the serving BS and for configuring clusters, and the UE is provided. The serving BS apparatus includes a cluster information managing unit for storing information about a plurality of clusters including the serving BS, a signal generating unit for generating cluster set information indicating information about the plurality of clusters, a transmitter for broadcasting the generated cluster set information to the UE, and a receiver for receiving a report of information about RSSIs of control signals transmitted from BSs included in the plurality of clusters from the UE, wherein the cluster information managing unit manages the information about the RSSIs of the controls signals, and maintains and manages the information about the clusters including the corresponding serving BS.

In accordance with another aspect of the present invention, a UE apparatus for determining a cluster which services a UE in a wireless communication system which includes a serving BS, a plurality of DBSs including peripheral BSs for cooperating with the serving BS and for configuring clusters, and the UE is provided. The UE apparatus includes a receiver for receiving cluster set information indicating information about a plurality of clusters, which is broadcasted from the serving BS, an RSSI measuring unit for measuring RSSIs of control signals transmitted from BSs included in the plurality of clusters, and a transmitter for reporting information about the measured RSSIs to the serving BS, wherein the receiver receives a message from the serving BS which assigns any one cluster selected among the plurality of clusters to a serving cluster for a data service based on the information about the RSSIs of the control signals.

Other aspects, advantages, and salient features of the invention will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses exemplary embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of certain exemplary embodiments of the present invention will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a wireless communication system according to an exemplary embodiment of the present invention;

FIG. **2** illustrates a basic concept of multi-tier clustering according to an exemplary embodiment of the present invention;

FIG. **3** illustrates a process of managing a cluster set while being classified according to Base Stations (BSs) under a multi-tier clustering structure according to an exemplary embodiment of the present invention;

FIG. **4** is a block diagram illustrating a configuration of a system for a multi-tier clustering operation according to an exemplary embodiment of the present invention;

FIG. **5** illustrates a process of a basic operation for illustrating principles of a multi-tier clustering operation according to an exemplary embodiment of the present invention;

FIGS. **6**A through **6**C illustrate a process of a multi-tier clustering operation according to an exemplary embodiment of the present invention;

FIG. **7** illustrates a concept to which multi-tier clustering and a resource allocation algorithm are applied according to an exemplary embodiment of the present invention;

FIG. **8** is a signal sequence diagram illustrating a system operation for determining a cluster for servicing a User Equipment (UE) according to an exemplary embodiment of the present invention;

FIGS. **9** and **10** are signal sequence diagrams illustrating a process of transmitting cluster set information at a serving Distributed BS (DBS) and transmitting a response therefor at a UE according to an exemplary embodiment of the present invention;

FIG. **11** is a signal sequence diagram illustrating a system operation for determining a cluster for servicing a UE according to an exemplary embodiment of the present invention;

FIG. **12** is a flowchart illustrating a process for managing a candidate serving cluster set while being classified according to users according to an exemplary embodiment of the present invention;

FIG. **13** is a flowchart illustrating a process for managing a candidate serving cluster set while being classified according to users according to an exemplary embodiment of the present invention;

FIG. **14** is a signal sequence diagram illustrating a process for a change operation to a cluster having a different tier users according to an exemplary embodiment of the present invention;

FIG. **15** is a signal sequence diagram illustrating a process for a change operation to a cluster having a different tier according to an exemplary embodiment of the present invention; and

FIGS. **16** through **18** illustrate different applicable environments according to exemplary embodiments of the present invention.

Throughout the drawings, it should be noted that like reference numbers are used to depict the same or similar elements, features, and structures.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The following description with reference to the accompanying drawings is provided to assist in a comprehensive understanding of exemplary embodiments of the invention as defined by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the embodiments described herein can be made without departing from the scope and spirit of the invention. In addition description of well-known functions and constructions may be omitted for clarity and conciseness.

The terms and words used in the following description and claims are not limited to the bibliographical meanings, but, are merely used by the inventor to enable a clear and

consistent understanding of the invention. Accordingly, it should be apparent to those skilled in the art that the following description of exemplary embodiments of the present invention is provided for illustration purpose only and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

It is to be understood that the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a component surface" includes reference to one or more of such surfaces.

By the term "substantially" it is meant that the recited characteristic, parameter, or value need not be achieved exactly, but that deviations or variations, including for example, tolerances, measurement error, measurement accuracy limitations and other factors known to those of skill in the art, may occur in amounts that do not preclude the effect the characteristic was intended to provide.

FIG. **1** illustrates a wireless communication system according to an exemplary embodiment of the present invention.

Referring to FIG. **1**, the wireless communication system includes a plurality of User Equipments (UEs) UE**0** **10** to UE**5** **15**, a plurality of Distributed Base Stations (DBSs) DBS**0** **20** to DBS**4** **24**, a macro BS **30** of an upper node of the DBS**0** **20** to the DBS**4** **24**, and a Central Management Unit (CMU) **40**. The CMU **40** is a central control device for controlling cooperative transmission and reception of the DBS**0** **20** to the DBS **4** **24**, and may be included in the macro BS **30**. The DBS**0** **20** to the DBS**4** **24** perform Multi-Input Multi-Output (MIMO) cooperative transmission and reception and configure a cooperative cluster. The DBS**0** to the DBS**4** **24** include all or some functions of general BSs.

The macro BS **30** supports a wireless backhaul function of each of the DBS**0** **20** to DBS**4** **24**, and includes a Beam Division Multiple Access (BDMA) antenna **50**. Each of the DBS**0** **20** to the DBS**4** **24** and each of the UE**0** **10** to the UE**5** **15** include an antenna corresponding to the BDMA antenna **50** to perform cooperative transmission and reception. The macro BS **30** and the DBSs are connected through a wireless backhaul link and the DBSs are connected through a wireless backhaul link. For example, the macro BS **30** and each of the DBS**0** **20**, the DBS**1** **21**, and the DBS**2** **23** are connected through the wireless backhaul link. In addition, the DBS**0** **20** and the DBS**2** **22** are connected through the wireless backhaul link, and the DBS**3** **23** and the DBS**4** **24** are connected through the wireless backhaul link. Each of the UE**0** **10** to the UE**5** **15** and each of the DBS**0** **20** to the DBS**4** **24** are connected through a wireless access link. For example, the UE**0** **10** and the UE**1** **11** are connected to the DBS**0** **20** through the wireless access link, and the UE**1** **11**, the UE**2** **12**, and the UE**3** **13** are connected to the DBS**2** **22** through the wireless access link. The UE**4** **14** are connected to the DBS**1** **21** through the wireless access link, and the UE**4** **14** is connected to the DBS **3** **23** through the wireless access link. The UE**5** **15** is connected to the DBS**4** **24** through the wireless access link.

As shown in FIG. **1**, exemplary embodiments of the present invention described below may be applied to an outdoor Virtual Cellular Network (VCN) environment in which a plurality of cooperated DBSs are distributed. In addition, exemplary embodiments of the present invention may also be applied to an outdoor distributed antenna environment and an in-building wireless network environment.

In accordance with exemplary embodiments of the present invention, multi-tier clustering has various types according to an inter-cell interference influence in environments in which BSs are randomly distributed. Herein, one BS is included in clusters of two or more different tiers. For example, one BS has a type which is overlapped to two or more different clusters. As described above, exemplary embodiments of the present invention may minimize an interference problem between clusters according to tier selection by users and may provide flexible environments for adding, changing, or removing BSs.

In accordance with exemplary embodiments of the present invention, a corresponding cluster set management operation by BSs and serving clustering allocation by UEs are performed. For example, a cluster set to which BSs may belong to while being classified according to the BSs which are preset by multi-tier clustering and related information are managed, and a serving cluster is assigned based on interference environments by UEs. Therefore, users may be allocated to a cluster which may minimize an interference influence among previously configured cluster patterns.

FIG. **2** illustrates a basic concept of multi-tier clustering according to an exemplary embodiment of the present invention.

Referring to FIG. **2**, DBSs DBS**0** to DBS**7** perform MIMO cooperative transmission and reception. For example, the DBS**0** may cooperate with the DBS **1** and the DBS**2** which are neighboring BSs. The DBS**3** may cooperate with the DBS**4** and the DBS**7** and the DBS**5** may cooperate with the DBS**6**.

The DBS**0** to the DBS**7** configure cooperative clusters for cooperative transmission and reception. In a tier 1 **101**, the DBS**0**, the DBS**1**, and the DBS**2** configure one cluster, the DBS**3**, the DBS**4**, and the DBS**7** configure one cluster, and the DBS**5** and the DBS**6** configure one cluster. In a tier N **10**N, the DBS**0**, the DBS**3**, and the DBS**4** configure one cluster, and the DBS**1**, the DBS**2**, and the DBS**5** configure one cluster. The DBS**0** is included in one cluster of the tier 1 **101** and is included in one cluster of the tier N **10**N. For example, the DBS**0** is included in two or more clusters.

FIG. **3** illustrates a process of managing a cluster set while being classified according to BSs under a multi-tier clustering structure according to an exemplary embodiment of the present invention.

Referring to FIG. **3**, DBS DBS**2** is included in clusters C**1** to C**3**, and store information about each of the clusters C**1** to C**3**. The cluster C**1** includes a DBS**1**, the DBS**2**, and a DBS**3**. The cluster **2** includes the DBS**1**, the DBS**2**, and the DBS**4**. The cluster C**3** includes the DBS**2**, the DBS**3**, and a DBS**5**. In addition, the DBS**2** transmits cluster set information to a UE**0** and assigns any one of a plurality of clusters while being classified according to UEs.

FIG. **4** is a block diagram illustrating a configuration of a system for a multi-tier clustering operation according to an exemplary embodiment of the present invention.

Referring to FIGS. **1** and **4**, the CMU **40** includes a multi-tier clustering configuring unit **401**, a resource allocating unit **402**, and a transceiver **403**. The multi-tier clustering configuring unit **401** configures and stores a plurality of cluster patterns in advance, each of which is configured as a disjoint DBS set in certain DBS distribution environments. The resource allocating unit **402** selects one or more clusters while being classified according to UEs among the plurality of cluster patterns and allocates (specifies) a serving cluster. The transceiver **403** transmits and receives signals with the DBSs **20** to **24**. For example, the transceiver **403** receives information about a Received Signal Strength Indicator (RSSI) from each of the DBSs **20**-**24**. In addition, the transceiver **403** transmits information about the serving

cluster allocated by the resource allocating unit **402** to each of the DBSs **20** to **24**. The CMU **40** may be included in the macro BS **30** of FIG. **1**.

The DBS **20** includes a cluster information managing unit **201**, a signal generating unit **202**, an RSSI measuring unit **203**, and a transceiver **204**. The other DBSs **21** to **24** are configured and operated to be identical to the DBS **20**. The cluster information managing unit **201** interworks with the CMU **40** and manages information about clusters including its DBS. In addition, the cluster information managing unit **201** also assigns the serving cluster selected by the CMU **40** to each of UEs **10** to **15**. The signal generating unit **202** generates cluster set information indicating information about clusters, which is stored in the cluster information managing unit **201**, and generates a pilot signal as a downlink control signal. The RSSI measuring unit **203** measures an RSSI for a control signal transmitted from each of the UEs **10** to **15**. The transceiver **204** is responsible for transmitting and receiving signals with each of the UEs **10** to **15**, each of the neighboring DBSs **21** to **24**, and the CMU **40**. For example, the transceiver **204** transmits the control signal and the cluster set information generated by the signal generating unit **202** and receives a control signal from each of the UEs **10** to **15**. In addition, the transceiver **204** transmits information about the RSSI measured by the RSSI measuring unit **203** to the CMU **40** and receives the information about the serving cluster, which is transmitted from the CMU **40**.

Each of the UEs **10** to **15** includes a signal generating unit **111**, an RSSI measuring unit **112**, and a transceiver **113**. The signal generating unit **111** generates a pilot signal as an uplink control signal and generates information about an RSSI measured by the RSSI measuring unit **112**. The RSSI measuring unit **112** measures an RSSI about a control signal received from each of DBSs **20** to **24**. The transceiver **113** transmits signals with each of the DBSs **20** to **24**. For example, the transceiver **113** receives a downlink control signal transmitted from each of the DBSs **20** to **24**. In addition, the transceiver **113** transmits the uplink control signal generated by the signal generating unit **111** and information about the RSSI measured by the RSSI measuring unit **112** to each of the DBSs **20** to **24**. The CMU **40** and each of the DBSs **20** to **24** may be connected through a wireless backhaul link. Each of the DBSs **20** to **24** and each of the UEs **10** to **15** may be connected through a wireless access link.

Although the CMU **40**, the DBSs **20** to **24**, and the UEs **10** to **15** are described with reference to an example shown in FIG. **4**, they are functional blocks according to exemplary embodiments of the present invention. It is possible for the CMU **40**, the DBSs **20** to **24**, and the UEs **10** to **15** to be configured by other blocks for performing the same functions. When the CMU **40**, the DBSs **20** to **24**, and the UEs **10** to **15** perform operations which are different from exemplary embodiments of the present invention, they may be configured by different blocks.

FIG. **5** illustrates a process of a basic operation for illustrating principles of a multi-tier clustering operation according to an exemplary embodiment of the present invention.

Referring to FIG. **5**, clusters C**11** to C**13** are included in a tier 1 **101**. The cluster C**11** includes DBSs DBS**1** and DBS**2**. The cluster C**12** includes DBSs DBS**3** and DBS**4**. The cluster C**13** includes DBSs DBS**5** and DBS**6**. Clusters C**21** to C**24** are included in a tier 2 **102**. The cluster C**21** includes the DBS**1**. The cluster C**22** includes the DBS**2** and the DBS**3**. The cluster C**23** includes the DBS**4** and the DBS**5**. The cluster C**24** includes the DBS**6**. As described above, in accordance with a multi-tier clustering structure, the clusters between tiers have an intertwined type and one DBS may be included in two or more clusters.

In a long-term aspect, the multi-tier clustering structure is configured in advance in consideration of DBS/statistical user distribution. It is possible to perform clustering of various types according to an inter-cell interference influence in environments in which DBSs are randomly distributed. This structure configures a basic framework for long-term resource allocation, such as frequency reuse. Accordingly, the structure minimizes an interference problem in clusters according to tier selection by users and provides a flexible environment for adding, changing, and removing DBSs.

In a mid-term aspect, different resources (e.g., frequencies/time) may be allocated to each tier according to physical position distribution of users. For example, resources are allocated based on a mutual influence of clusters between tiers and by tiers in consideration of a performance limitation (e.g., a transmission power) by DBSs. In another exemplary method, it is possible to consider a generalized algorithm which reuses the same frequency/time resources between clusters which are positioned in different tiers. Therefore, a dynamic topology corresponding to distribution of users and an amount of loads is configured.

In a short-term aspect, a beam control operation according to network MIMO is performed in each of clusters to address a boundary problem between DBS cells.

FIGS. **6**A through **6**C illustrate a process of a multi-tier clustering operation according to an exemplary embodiment of the present invention.

Referring to FIG. **6**A, a network MIMO operation is performed while being classified according to clusters. Different resources (e.g., frequencies) are allocated while being classified according to tiers **101** and **102**.

Referring to FIG. **6**B, when user distribution is changed, frequency/time resource allocation between tiers/clusters is changed. In addition, it is possible to perform load balancing between tiers.

Referring to FIG. **6**C, it is unnecessary to consider only use of different frequencies/resources between tiers. It is possible to consider generalized resource allocation. A topology is configured to correspond to installation change, addition, and removal of DBSs. It is possible to permit complexity of a suitable level by an operation of a long-term period.

FIG. **7** illustrates a concept to which multi-tier clustering and a resource allocation algorithm are applied according to an exemplary embodiment of the present invention.

Referring to FIG. **7**, DBSs configure multi-tier cooperative clusters for cooperative transmission and reception. For example, in a tier 1 **101**, DBSs DBS**0** to DBS**2** configure one cluster, DBSs DBS**3**, DBS**4**, and DBS**7** configure one cluster, and DBSs DBS**5** and DBS**6** configure one cluster. In a tier N **10**N, the DBS**0**, the DBS**3**, and the DBS**4** configure one cluster and the DBS**1**, the DBS**2**, and the DBS**5** configure one cluster. The DBS**0** is included in one cluster of the tier 1 **101** and is included in one cluster of the tier N **10**N. Accordingly, the DBS**0** is included in two or more clusters.

A network MIMO operation, that is, an intra-cluster beamforming operation is performed in the cluster by the DBS**0**, the DBS**3**, and the DBS**4** of the tier N **10**N. The tier 1 **101** and the tier N **10**N allocate different frequency/time/power resources between tiers and clusters. In another exemplary method, it is possible to consider when the same frequency/time resources are reused between tiers.

FIG. **8** is a signal sequence diagram illustrating a system operation for determining a cluster for servicing a UE according to an exemplary embodiment of the present invention.

Referring to FIG. **8**, a serving DBS among DBSs transmits a downlink control signal to a UE to perform a cluster selection operation. In step **80**, a CMU configures and manages information about clusters in advance. For example, a serving DBS (i.e., a home DBS) DBS**0** and neighboring DBSs DBS**1** and DBS**2** configure a cluster **1**. The serving DBS DBS**0** and neighboring DBSs DBS**3** and DBS**4** configure a cluster **2**. The serving DBS DBS**0** and the neighboring DBSs DBS**2** and DBS**3** configure a cluster **3**.

In step **81**, the serving DBS DBS**0** configures primary control channels with a UE UE**0**. In step **82**, the serving DBS DBS**0** broadcasts candidate cluster set information indicating information about a plurality of clusters including it to the UE UE**0**. The cluster set information includes corresponding DBS information and information of a transmission and reception method by clusters, and the like. The cluster set information is periodically or intermittently transmitted.

In response to the broadcasting of the cluster set information, in step **83**, each of the serving DBS DBS**0** and the neighboring DBSs DBS**1** to DBS**4** generates a pilot signal, which is a downlink control signal, and transmits the generated pilot signal to the UE UE**0**.

The UE UE**0** receives the pilot signals transmitted from the DBSs. It is possible for the UE UE**0** to receive a plurality of DBS signals in environments in which a plurality of DBSs are randomly distributed. Herein, if there is a particular preference cluster, it is possible for the UE UE**0** to receive only a DBS signal related to the corresponding cluster or receive only signals of predefined RSSI or more. In step **84**, the UE UE**0** measures an RSSI for each of the pilot signals transmitted from the DBSs and transmits the measured RSSI information to the serving DBS DBS**0**. For example, the UE UE**0** transmits RSSI information about pilot signals received from previously selected DBSs DBS**0** and DBS**2** to DBS**4** to the serving DBS DBS**0**. Accordingly, the serving DBS DBS**0** receives a report of information about RSSIs of control signals transmitted from DBSs included in the plurality of clusters from the UE UE**0**. The information about the RSSIs of the control signals may include information about DBSs by clusters and a value of an RSSI corresponding to each of DBSs. In another exemplary method, the information about the RSSIs of the control signals may include a value of an RSSI corresponding to each of DBSs by clusters in the order included in the cluster set information.

In step **85**, the serving DBS DBS**0** transmits the information of the RSSIs of the control signals to the CMU. The CMU determines candidate clusters among the plurality of clusters based on the information about the RSSIs of the control signals and assigns any one of the determined candidate clusters to a cluster for servicing the UE UE**0**. More specifically, in step **85**, the CMU determines the candidate clusters among the clusters based on the information of the RSSIs of the control signals and selects an optimal cluster among the candidate clusters. For example, the cluster **2** and the cluster **3** may be determined on the candidate clusters and the cluster **2** may be selected as an optimal cluster. Information about the optimal cluster is transmitted to the serving DBS DBS**0**.

In step **86**, the serving DBS DBS**0** transmits an assignment message indicating that the selected cluster is assigned to a serving cluster for servicing the UE UE**0** to the UE UE**0**. In step **87**, the serving DBS DBS**0** configures primary control channels. In step **88**, the DBS DBS**0** performs data transmission and reception with the UE UE**0** through a newly assigned cluster **2**.

FIGS. **9** and **10** are signal sequence diagrams illustrating a process of transmitting cluster set information at a serving DBS and transmitting a response therefor at a UE according to an exemplary embodiment of the present invention.

Referring to FIGS. **9** and **10**, in step **90**, the serving DBS DBS**0** manages information of clusters including it. In step **91**, the serving DBS DBS**0** transmits information of related clusters as cluster set information periodically or intermittently. The information of the related clusters includes corresponding DBS information and information of a transmitting and receiving method by clusters, and the like.

For example, in step **91** of FIG. **10**, the cluster set information may include a reference number of the cluster set information, and DBS information and frequency information by clusters. A DBS**1**, a DBS**2**, and a DBS**3** are included in a cluster **1**, and DBSs of the cluster **1** perform a transmission and reception operation in a frequency **1**. The DBS**1**, the DBS**3**, and a DBS**5** are included in a cluster **2**, and DBSs of the cluster **2** perform a transmission and reception operation in a frequency **2**. The DBS**1**, a DBS**4**, and a DBS**6** are included in a cluster **3**, and DBSs of the cluster **3** perform a transmission and reception operation in a frequency **3**. The DBS**1** and the DBS**2** are included in a cluster **4**, and DBSs of the cluster **4** perform a transmission and reception operation in the frequency **3**.

In step **92**, the UE UE**0** measures a related DBS receiving signal based on the cluster set information. It is possible for the UE UE**0** to receive a plurality of DBS signals in environments in which a plurality of DBSs are randomly distributed. In addition, there is a particular preference cluster, it is possible for the UE UE**0** to receive only a DBS signal related to the corresponding cluster. In step **93**, each of the serving DBS DBS**0** and the neighboring DBSs DBS**1** to DBS**4** transmits a downlink pilot signal to the UE UE**0**. In step **94**, the UE UE**0** measures signal quality (RSSI) for a selected DBS.

In step **95**, the UE UE**0** reports information about the RSSI to the serving DBS DBS**0**. When reporting channel measurement in step **95**, the information about the RSSI may include cluster information (ID), DBS information (ID), and signal quality information (i.e., an RSSI value). In another exemplary method, it is possible to report a cluster ID and signal quality information by DBSs without a separate DBS ID in the order of DBSs included in the cluster set information. For example, in step **95** of FIG. **10**, the UE UE**0** reports three RSSI values without a DBS ID with respect to a cluster #**1** and reports two RSSI values without a DBS ID with respect to a cluster #**4**. The three RSSI values for the cluster #**1** are RSSI values of signals transmitted from DBSs according to the order included in the cluster set information. A first RSSI value is an RSSI value of a signal transmitted from the DBS**1**, a second RSSI value is an RSSI value of a signal transmitted from the DBS**2**, and a third RSSI value is an RSSI value of a signal transmitted from the DBS**3**. Although the UE UE**0** does not report a separate DBS ID, because the serving DBS DBS**0** knows the order of DBSs by clusters, it may know whether an RSSI value is an RSSI value of a signal transmitted from any DBS. In this case, the UE UE**0** may reduce a length of information transmitted to the serving DBS DBS**0**.

As described above, each of DBSs broadcasts information about one or more clusters including it while being classified according to DBSs. Receiving interference, a UE measures

and reports signals of a serving DBS and neighboring DBSs based on corresponding cluster information.

FIG. **11** is a signal sequence diagram illustrating a system operation for determining a cluster for servicing a UE according to an exemplary embodiment of the present invention.

Referring to FIG. **11**, a UE transmits an uplink control signal to DBSs to perform a cluster selection operation. In step **110**, a CMU configures and manages information about clusters in advance. For example, a serving DBS (i.e., a home DBS) DBS**0** and neighboring DBSs DBS**1** and DBS**2** configure a cluster **1**. The serving DBS DBS**0** and neighboring DBSs DBS**3** and DBS**4** configure a cluster **2**. The serving DBS DBS**0** and the neighboring DBSs DBS**2** and DBS**3** configure a cluster **3**.

In step **111**, the serving DBS DBS**0** configures primary control channels with a UE UE**0**. In step **112**, the serving DBS DBS**0** allocates a pilot or sounding signal which is an uplink control signal to the UE UE**0**.

In step **113**, the UE UE**0** broadcasts the pilot signal which is the uplink control signal to the serving DBS DBS**0** and the neighboring DBSs DBS**1** to DBS**4**.

In step **114**, each of the DBSs DBS**0** to DBS**4** measures an RSSI of a signal transmitted from the UE UE**0** and reports the measured result to the CMU which is an upper node.

In step **115**, the CMU receives information about an RSSI transmitted from each of the DBSs, determines candidate clusters among the clusters based on the information about the RSSI, and selects an optimal cluster from the determined candidate clusters. For example, the cluster **2** and the cluster **3** may be determined on the candidate clusters and the cluster **2** may be selected as an optimal cluster. Information about the optimal cluster is transmitted to the serving DBS DBS**0**.

In step **116**, the serving DBS DBS**0** transmits an assignment message indicating that the selected cluster is assigned to a serving cluster for servicing a UE to the UE UE**0**. In step **177**, the serving DBS DBS**0** configures primary control channels. In step **118**, the DBS DBS**0** performs data transmission and reception with the UE UE**0** through a newly assigned cluster **2**.

FIG. **12** is a flowchart illustrating a process for managing a candidate serving cluster set while being classified according to users according to an exemplary embodiment of the present invention. The process of FIG. **12** corresponds to the process of FIG. **8**.

Referring to FIG. **12**, in step **121**, each of DBSs broadcasts a unique downlink signal while being classified according to DBSs. In step **122**, a UE measures an RSSI of the downlink signal received from each of the DBSs. In step **123**, the UE reports an RSSI of a certain level or more, or reports the measured RSSI to a previously selected DBS.

In step **124**, the resource allocating unit **402** of the CMU **40** of FIG. **4** collects information related to an RSSI of each of DBSs, which is reported from a serving DBS. In step **125**, the resource allocating unit **402** sets candidate clusters while being classified according to UEs based on the reported RSSI information.

FIG. **13** is a flowchart illustrating a process for managing a candidate serving cluster set while being classified according to users according to an exemplary embodiment of the present invention. The process of FIG. **13** corresponds to the process of FIG. **11**.

Referring to FIG. **13**, in step **131**, each of UEs broadcasts a unique uplink signal in a certain area. In step **132**, each of DBSs measures an RSSI of the received uplink signal.

In step **133**, the resource allocating unit **402** of the CMU **40** of FIG. **4** collects information related to an RSSI reported from each of the DBSs. In step **134**, the resource allocating unit **402** sets candidate clusters while being classified according to UEs based on the reported RSSI information.

FIG. **14** is a signal sequence diagram illustrating a process for a change operation to a cluster having a different tier according to an exemplary embodiment of the present invention.

Referring to FIG. **14**, a home DBS transmits a downlink control signal to a UE to perform a cluster change operation.

In step **140**, the UE performs data transmission and reception with DBSs included in a cluster C**11** of a tier 1 **101**. When a user moves from a middle point of the cluster C**11** to a boundary region (i.e., a middle point of a cluster **22** of a tier 2 **102**) between the cluster C**11** and a cluster C**12** of the tier 1 **101** while a data service is performed through the cluster C**11**, the home DBS broadcasts Cluster-SET ADVanced (C-SET ADV) information indicating information about a plurality of clusters including it to the UE in step **141**. In step **142**, each of the home DBS and neighboring DBSs transmits a pilot signal which is a downlink control signal to the UE.

In step **143**, the UE measures an RSSI of the pilot signal transmitted from each of the home DBS and the neighboring DBSs which are included in a plurality of clusters and reports information (i.e., pilot signal measurement information) about the RSSI indicating the measured result to the home DBS. The information about the RSSI may include information about RSSIs of control signals transmitted from predefined DBSs among DBSs included in the clusters. In one example, the predefined DBSs may be DBSs which transmit a control signal of an RSSI which is greater than a predefined RSSI among the control signals. In another example, the predefined DBSs may be DBSs included in previously selected clusters. The information about the RSSIs of the control signals may include information about DBSs by clusters and a value of an RSSI corresponding to each of DBSs. In another exemplary method, the information about the RSSIs of the control signals may include a value of an RSSI corresponding to each of DBSs by clusters in the order included in the cluster set information.

In step **144**, the home DBS receives the information about the RSSIs from the UE and reports the received information to a CMU **40** which is an upper node. In step **145**, the CMU resets candidate clusters based on the information about the RSSIs. In step **146**, the CMU determines a change to a cluster having a different tier by selecting an optimal cluster among the candidate clusters. When the user is moved, the cluster C**22** of the tier 2 **102** may be selected as an optimal cluster. When the change of the cluster is determined, a change procedure to a cluster having a different tier is performed in step **147**. As shown in FIG. **8**, the change procedure of the cluster may include the process of assigning a serving cluster and the process of configuring primary control channels. In step **148**, a data service (i.e., transmission and reception) is performed between DBSs included in the cluster C**22** of the tier 2 **102** and a UE which moves its position.

FIG. **15** is a signal sequence diagram illustrating a process for a change operation to a cluster having a different tier according to an exemplary embodiment of the present invention.

Referring to FIG. **15**, a UE transmits an uplink control signal to a home DBS and neighboring DBSs to perform a cluster change operation.

In step **150**, the UE performs data transmission and reception with DBSs included in a cluster C**11** of a tier 1 **101**. When a user moves from a middle point of the cluster C**11** to a boundary region (i.e., a middle point of a cluster **22** of a tier 2 **102**) between the cluster C**11** and a cluster C**12** of the tier 1 **101** while a data service is performed through the cluster C**11**, the UE broadcasts a pilot signal which is an uplink control signal to home DBS and neighboring DBSs in step **151**.

In step **152**, each of the home DBS and the neighboring DBSs receives the pilot signal, measures an RSSI of the pilot signal, and transmits the measured result to a CMU **40**.

In step **153**, the CMU resets candidate clusters based on information about the RSSI. In step **154**, the CMU determines a change to a cluster having a different tier by selecting an optimal cluster among the candidate clusters. When the user is moved, the cluster C**22** of the tier 2 **102** may be selected as an optimal cluster. When the change of the cluster is determined, a change procedure to a cluster having a different tier is performed in step **155**. As shown in FIG. **11**, the change procedure of the cluster may include the process of assigning a serving cluster and the process of configuring primary control channels. In step **156**, a data service (i.e., transmission and reception) is performed between DBSs included in the cluster C**22** of the tier 2 **102** and a UE which moves its position.

As described above, exemplary embodiments of the present invention may reduce an interference problem between clusters by applying a multi-tier clustering method.

In addition, exemplary embodiments of the present invention may reduce complexity gradually through multi-tier clustering/resource allocation/cooperative multi-antenna transmission and reception. It is possible to perform an operation of a UE/traffic distribution adaptive system.

In addition, exemplary embodiments of the present invention may reduce an overhead of an uplink measurement report message by measuring a neighboring DBS signal of a UE based on cluster set information transmitted from DBSs.

In addition, exemplary embodiments of the present invention may perform quick and efficient load balancing between clusters through a plurality of candidate serving cluster set management by UEs.

In addition, exemplary embodiments of the present invention may perform a systematic operation between multi-antenna cooperative transmission and reception and frequency reuse to address an interference problem between cooperative DBS clusters in a plurality of DBS distribution environments.

FIGS. **16** through **18** illustrate different applicable environments according to exemplary embodiments of the present invention.

FIG. **16** illustrates an outdoor VCN environment according to exemplary embodiments of the present invention.

Referring to FIG. **16**, in accordance with the VCN environment, a plurality of DBSs may be randomly distributed. Each of UEs receives high-capacity wireless data from each of the DBSs. The DBSs are classified into a cluster C**11**, a cluster C**12**, and a cluster C**13** in a tier 1 (displayed by solid lines) and are classified into a cluster C**21** and a cluster C**22** in a tier 2 (displayed by dotted lines). The DBSs may be connected to a central control device (central management unit) through wireless backhaul or wired backhaul and may perform intra-cluster cooperative communication. The central control device may be a macro BS which services a larger area.

FIG. **17** illustrates an outdoor distributed antenna environment according to an exemplary embodiment of the present invention.

Referring to FIG. **17**, in accordance with the distributed antenna environment, a wireless transmission and reception controller/central controller which processes signals in a baseband is separated from a wireless transceiver. For example, the wireless transceiver may be a distributed antenna and a Remote Radio Head (RRH). The wireless transmission and reception controller/central controller may be a CMU **40**.

A plurality of wireless transceivers are physically distributed and positioned from the wireless transmission and reception controller/central controller, and are connected to the wireless transmission and reception controller/central controller through a wired link (e.g., a Radio Frequency (RF) over fiber). The wireless transceivers are classified into a cluster C**11**, a cluster C**12**, and a cluster C**13** in a tier 1 (displayed by solid lines) and are classified into a cluster C**21** and a cluster C**22** in a tier 2 (displayed by dotted lines).

FIG. **18** illustrates an in-building wireless network environment according to an exemplary embodiment of the present invention.

Referring to FIG. **18**, in accordance with the wireless network environment, a plurality of Remote Hub Unit (RHU)/Remote Units (RUs) are distributed in a building. Cooperation between DBSs/antennas may be performed by a Main Hub Unit (MHU). The RHU and the RUs are connected through an RF (cable), and the RHU and the MHU are connected through an Intermediate Frequency (IF) (optic). The MHU is connected to a Remote Access Server (RAS)+Reporting Activity Routing Identifier (RARI) through an analog IF (cable). The RUs may implement clusters according to distributed types. An indoor VCN is implemented by this wireless network environment.

As described above, while the present invention has been particularly shown and described with reference to exemplary embodiments and drawings thereof, it is not limited to the exemplary embodiments. For example, in an exemplary embodiment of the present invention, an example of selecting a specific cluster from clusters including DBSs under an outdoor VCN environment and performing a change from a cluster of the related art to a different cluster is described. However, exemplary embodiments of the present invention may be equally applied in an outdoor distributed antenna environment including a plurality of units which cooperate with each other and perform a transmission and reception function and an in-building wireless network environment to be similar with the outdoor VCN environment.

On the other hand, operations according to exemplary embodiments of the present invention may be recorded in a computer readable medium including program instructions for performing operations implemented by various computers. The computer readable medium may include program instructions, data files, data structures, and the like, separately or by combination of them. The program instructions may be particularly designed and configured for the present invention, or is well known to those skilled in the art and may be used. The computer readable medium includes any one of magnetic media, such as a hard disc, a floppy disc, and a magnetic tape, an optical recording media, such as Compact Disc-Read Only Memories (CD-ROMs) or Digital Video Discs (DVDs), a magneto-optical media, such as floptical discs, and hardware devices, such as a ROM, a Random Access Memory (RAM), and a flash memory, to be particularly configured to store and perform program instructions. The program instructions include machine lan-

guage codes, such as codes generated by compilers and high-level language codes capable of being executed by computers using an interpreter, and the like. When all or some of BSs and relays described in exemplary embodiments of the present invention are implemented by a computer program, a computer readable medium which stores the computer program is also included in the present invention.

While the invention has been shown and described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A method in a serving base station (BS) in a wireless communication system, the method comprising:

transmitting, to a terminal, information regarding a plurality of clusters, each of the plurality of clusters including the serving BS and at least one neighboring BS connected to the serving BS through a backhaul link;

receiving, from the terminal, information regarding received signal strength for control signals transmitted from BSs included in each of the plurality of clusters;

transmitting, to an upper node, the information regarding the received signal strength;

receiving, from the upper node, information regarding an optimal cluster selected from among the plurality of clusters based on the information of the received signal strength;

determining a cluster selected from among the plurality of clusters as a serving cluster for servicing the terminal, based on the information about the optimal cluster; and

communicating with the terminal by cooperating with at least one BS included in the serving cluster through the backhaul link.

2. The method of claim **1**, further comprising:

receiving, from each of the at least one neighboring BS, information regarding received signal strength of signal transmitted from the terminal;

determining a cluster selected from among the plurality of clusters as a serving cluster for servicing the terminal, based on the information of the received signal strength of the signal.

3. The method of claim **2**,

wherein the each of the at least one neighboring BS is a BS which transmits a control signal with received signal strength which is greater than a predefined signal strength among the control signals, or

wherein the each of the at least one neighboring BS is a BS included in previously selected clusters.

4. The method of claim **2**,

wherein the information of the received signal strength includes information about BSs by clusters and a value of received signal strength corresponding to each of the BSs, or

wherein the information regarding the received signal strength includes a value of the received signal strength corresponding to each of the BSs by clusters in an order included in the information regarding the plurality of clusters.

5. The processing method of claim **1**,

wherein the transmitting of the information regarding the plurality of clusters is periodically or intermittently performed, or

wherein the transmitting of the information regarding the plurality of clusters is performed when a position of the terminal is moved.

6. The method of claim **1**, further comprising: transmitting information about the serving cluster to the terminal.

7. A method in a terminal in a wireless communication system, the method comprising:

receiving, from a serving base station (BS), information regarding a plurality of clusters, each of the plurality of clusters including the serving BS and at least one neighboring BS connected to the serving BS through a backhaul link;

transmitting, to the serving BS, information of received signal strength regarding control signals transmitted from BSs included in each of the plurality of clusters; and

communicating with the serving BS which is cooperating, through the backhaul link, with at least one BS included in a cluster selected from among the plurality of clusters as a serving cluster, based on information about an optimal cluster,

wherein the optimal cluster is selected from among the plurality of clusters based on the information of the received signal strength.

8. The method of claim **7**, wherein the information regarding the received signal strength includes information about received signal strength for control signals transmitted from predefined BSs among the BSs included in each of the plurality of clusters.

9. The method of claim **8**,

wherein the predefined BSs are BSs which transmit a control signal with received signal strength which is greater than a predefined signal strength among the control signals, or

wherein the predefined BSs are BSs included in previously selected clusters.

10. The method of claim **8**,

wherein the information of the received signal strength includes information about BSs by clusters and a value of received signal strength corresponding to each of the BSs, or

wherein the information of the received signal strength includes a value of the received signal strength corresponding to each of the BSs by clusters in an order included in the information regarding the plurality of clusters.

11. The method of claim **8**, further comprising:

receiving information about the serving cluster from the serving BS.

12. The processing method of claim **7**,

wherein the receiving of the information regarding the plurality of clusters is periodically or intermittently performed, or

wherein the receiving of the information regarding the plurality of clusters is performed when a position of the terminal is moved.

13. A serving base station (BS) apparatus in a wireless communication system, the apparatus comprising:

a transceiver; and

a processor coupled to the transceiver,

wherein the processor is configured to:

transmit, to a terminal, information regarding a plurality of clusters, each of the plurality of clusters including the serving BS and at least one neighboring BS connected to the serving BS through a backhaul link;

receive, from the terminal, information of received signal strength for control signals transmitted from BSs included in each of the plurality of clusters;

transmit, to an upper node, the information regarding the received signal strength;

receive, from the upper node, information about an optimal cluster selected from among the plurality of clusters based on the information of the received signal strength;

determine a cluster selected from among the plurality of clusters as a serving cluster for servicing the terminal, based on the information about the optimal cluster; and

communicate with the terminal by cooperating with at least one BS included in the serving cluster through the backhaul link.

14. The apparatus of claim **13**, wherein the processor is further configured to:

receive, from each of the at least one neighboring BS, information regarding received signal strength of signal transmitted from the terminal;

determine a cluster selected from among the plurality of clusters as a serving cluster for servicing the terminal, based on the information of the received signal strength of the signal.

15. The apparatus of claim **14**,

wherein the each of the at least one neighboring BS is a BS which transmits a control signal with received signal strength which is greater than a predefined signal strength among the control signals, or

wherein the each of the at least one neighboring BS is a BS included in previously selected clusters.

16. The apparatus of claim **14**,

wherein the information of the received signal strength includes information about BSs by clusters and a value of received signal strength corresponding to each of the BSs, or

wherein the information of the received signal strength includes a value of the received signal strength corresponding to each of the BSs by clusters in an order included in the information regarding the plurality of clusters.

17. The serving BS apparatus of claim **13**,

wherein the information regarding the plurality of clusters is periodically or intermittently transmitted to the terminal, or

wherein the information regarding the plurality of clusters is transmitted to the terminal when a position of the terminal is moved.

18. The apparatus of claim **13**, wherein the processor is further configured to transmit information about the serving cluster to the terminal.

19. A terminal apparatus in a wireless communication system, the apparatus comprising:

a transceiver; and

a processor coupled to the transceiver,

wherein the processor is configured to:

receive, from a serving base station (BS), information regarding a plurality of clusters, each of the plurality of clusters including the serving BS and at least one neighboring BS connected to the serving BS through a backhaul link;

transmit, to the serving BS, information of received signal strength for control signals transmitted from BSs included in each of the plurality of clusters; and

communicate with the serving BS which is cooperating, through the backhaul link, with at least one BS included in a cluster selected from among the plurality of clusters as a serving cluster, based on information about an optimal cluster,

wherein the optimal cluster is selected from among the plurality of clusters based on the information of the received signal strength.

20. The apparatus of claim **19**, wherein the information of the received signal strength includes information about received signal strength for control signals transmitted from predefined BSs among the BSs included in each of the plurality of clusters.

21. The apparatus of claim **20**,

wherein the predefined BSs are BSs which transmit a control signal with received signal strength which is greater than a predefined strength among the control signals, or

wherein the predefined BSs are BSs included in previously selected clusters.

22. The apparatus of claim **20**,

wherein the information of the received signal strength includes information about BSs by clusters and a value of received signal strength corresponding to each of the BSs, or

wherein the information of the received signal strength includes a value of the received signal strength corresponding to each of the BSs by clusters in an order included in the information regarding the plurality of clusters.

23. The apparatus of claim **19**,

wherein the information regarding the plurality of clusters is periodically or intermittently received, or

wherein the information regarding the plurality of clusters is received when a position of the terminal is moved.

24. The apparatus of claim **19**, wherein the processor is further configured to receive information about the serving cluster from the serving BS.

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